U.S. Army Installation
Restoration Program

Background Data Analysis
for

ARSENIC, BARIUM, CADMIUM, CHROMIUM, & LEAD

on
Fort Wainwright, Alaska

FINAL

March 1994

US Army Corps
of Engineers
Alaska District

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Abbreviations

UCL . . . . . Upper Confidence Limit

MCL . . . . . Maximum Contaminant Level

RBC . . . . . Risk Based Concentration

HI . . . . . Hazard Index

HQ . . . . . Hazard Quotient

INTRODUCTION

This report summarizes the findings of a data search and of the calculation of a 95 percent Upper Confidence Limit (UCL) for background levels of arsenic, barium, cadmium, chromium and lead using groundwater and soil samples taken on Fort Wainwright, Alaska. These values are for use in the definition of **added risk** from inorganic contamination of areas on Fort Wainwright. Analysis of the background data will provide a basis for establishing clean-up levels for these metals on Fort Wainwright. The 95% UCL is defined as a value taken from randomly drawn subsets of site data that equals or exceeds the true mean 95 percent of the time (1). The UCL does not provide a maximum level of concentration due to background levels, it gives an estimated value for the mean background concentration. To calculate the UCL, the mean, standard deviation, an *h* or *t* statistic, and the number of samples are used. The *t* statistic is determined from the degrees of freedom (sample size minus 1) and the desired confidence level and is used for a normal distribution of data. The *h* statistic is used for a lognormal distribution and is determined from the degrees of freedom and the standard deviation. The UCL is used as the average concentration because of uncertainty in the distribution average. As the sample size increases, the UCL moves closer to the true mean. Data sets of 20 to 30 samples generally provide fairly consistent estimates of the true mean value (1).

Methods used in obtaining and manipulating the data will be provided along with a discussion of the data quality and of the geological formations in the area that produce the elements under consideration. The results will be presented along with graphs of the data used in the study and finally, the recommended background levels will be presented. Results will be compared to background UCL's for Eielson Air Force Base (AFB) and to the Geochemical Atlas of Alaska to show a range of values for the Chena-Tanana River Basin.

USE of REPORT

Investigators on Fort Wainwright should take background samples unique to the area being investigated. This report can be used to evaluate those samples on a broad area basis. Area unique background samples that are within one or two standard deviations of the mean, and not in excess of one standard deviation above the UCL demonstrate conditions similar to the data sets used in this report, and may use the reported UCLs as background values. Investigators finding area unique background values that are inconsistent with the UCLs reported should review the data sets used, both in this report and area unique, to determine whether the area under consideration is dissimilar to that evaluated in this report. This report should not be used to preclude background sampling in any area. It should be used to provide added strength to background data collected in each individual area, and allow fewer

provide added strength to background data collected on each individual area, and allow fewer area specific background samples to be taken, while not sacrificing the quality or strength of the background values established.

Specific procedures for comparing site and background conditions have not been specified by EPA, however a five-phase process for comparing sites to background along with six possible statistical tests is provided in a Battelle letter report (2). The process outlined in the Battelle letter report is the recommended process and should be followed whenever possible.

METHODS

Sample values were taken from the following investigative reports done on Fort Wainwright so that a large number of samples could be used in the statistical analysis and so that a costly special sampling event would not be needed:

Alaska District Corps of Engineers. Final Report, Power Plant Coal Yard. August 1991

Alaska District Corps of Engineers. Groundwater Monitoring Network Draft Report. August 1990

Alaska District Corps of Engineers. Groundwater Monitoring Network Report. August 1991

Ecology and Environment, Inc. Birch Hill Underground Storage Tank Site Draft Remedial Investigation. January 1993

Ecology and Environment, Inc. Fort Wainwright Landfill Report. August 1991

Ecology and Environment, Inc. Corrective Action Plan, PX Service Station Underground Storage Tank Site. March 1993

Ecology and Environment, Inc. Progress Report for the Confirmation of Fire Training Pits at Fort Richardson; Fort Wainwright, and Fort Greely, Alaska. February 1992

Harding Lawson Associates. Operable Unit 2, Preliminary Source Evaluation 2, Phase 1 Draft Report. November 1992

Harding Lawson Associates. Operable Unit 2, Preliminary Source Evaluation 2, Phase 2, Defense Reutilization Marketing Office Draft Report. February 1993

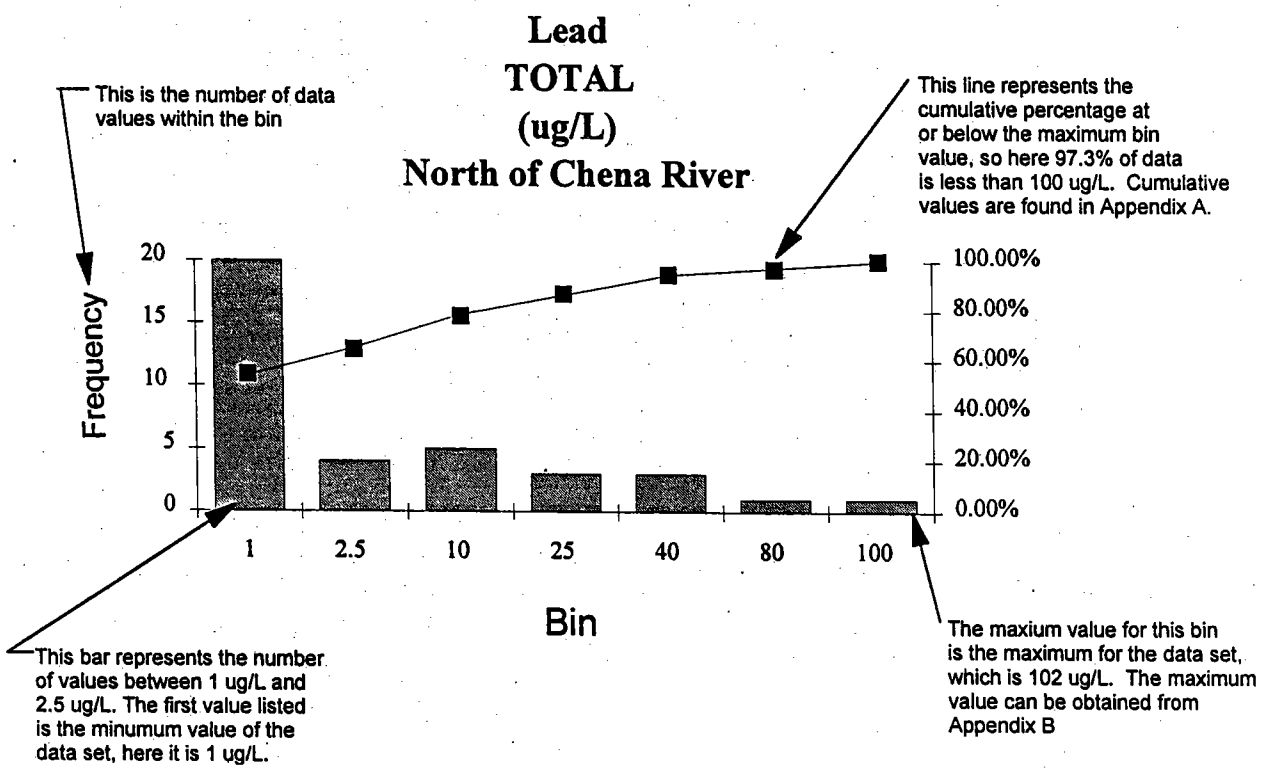
OHM Remediation Services Corp. Sampling & Analytical Final Report for Drummed Waste Removal. February 1993

Data from the reports was graphed in a histogram to determine distribution and to locate any outlying values. The outlying values were then located by boring log number. The boring log numbers for all the data were plotted onto a map of Fort Wainwright. Locations and titles of all the investigations done through the Alaska District, Corps of Engineers, on Fort Wainwright, were included on the map so that soil borings could be correlated with known contaminated areas. The map is provided in the back of this report. High sample values were highlighted on the map by color coding for each metal. Then, the highlighted sample locations were evaluated for sources of contamination. The evaluation process consisted of locating areas of contamination and then determining if transport to the sample area was possible. Areas associated with a type of contamination that would yield one of the metals of concern were considered for contamination through groundwater transport, windblown particulate, and soil migration. Sampling areas were not all specifically chosen for background, however, no samples were included from sites that were known to have metal contamination from an outside source. An explanation of why a particular sample was deleted and the value of the sample or samples deleted is furnished in the detailed descriptions that follow for each category of data. Every effort was made to locate contaminated samples in the data set and remove them, however there is heavy use of the area and there is no way to confirm that none of the samples have been impacted by contaminates from surrounding areas.

After deleting suspected contaminated values and validating the quality of the data (see Data Quality section below), new histograms were done to aid in determining whether the samples were distributed normally or lognormally. The distribution was determined by the visual appearance of the histogram and by comparing the skewness. The skewness for the data set was compared with skewness for the log of the data set and the absolute value of the smallest skew was used to determine distribution. Appendix A provides additional distribution information to the graphs presented in the Results section. Bin values for the histograms were chosen to best display distribution and each bin is the lower limit of the aggregate. Histograms for all the data are provided in each data category. An explanation of the histogram is provided in Figure A. Microsoft Excel was the software used for all data analysis. The 95% Upper Confidence Limit was determined according to EPA Publication 9285.7-081 (2). The UCL was determined using both a h statistic for a lognormal distribution and a t statistic for a normal distribution. Appendix B supplies a full statistical analysis along with the formulae used to calculate the UCL.

Explanation of Histograms:

Figure A



Dissolved and total groundwater samples were grouped separately and the Chena River was used as a boundary to categorize soil data. The data sets were originally divided into those occurring north of the Chena River, and those occurring south of the Chena River. This separation was based upon several premises. Water south of the Chena is impacted by the Tanana River (a perched river) providing water to the system, while groundwater north of the Chena is probably impacted by flow coming off of, and out of, the Birch Creek Schist forming the hills just north of the Chena. Although all of the granular material in the area of concern appears to be from Tanana origins, the close proximity of potentially highly mineralized deposits in the Birch Hill vicinity indicated a higher probability of finding mineralized sediments north of the Chena rather than south. These assumptions were tested analytically through the use of a student's t-test. The results of the t-test for total metals in groundwater indicated that the data sets were the same for both north and south, so the

sample values were combined and reanalyzed for the UCL. Combining the data sets caused a slight lowering of the UCL. The t-test results for soil indicated that the data from north of the Chena is different than that south of the Chena, so the UCL's were calculated separately. The dissolved water data was combined for north and south because there were not enough samples for adequate statistical analysis with the data separated. Appendix D contains the results of the student's t-test.

Soil samples used for analysis were taken at depths varying from 0.5 to 25 feet and one set of samples were taken at 40 feet below ground surface. The majority of samples were from the 0.5 to 15 feet below ground surface increment. There was a concern that the different soil types encountered on Fort Wainwright would have different levels of background minerals. A cursory comparison of the level of parameter (barium, arsenic, etc.) found in shallow samples to that found in deeper samples did not show any noticeable differences. This comparison involved the viewing of highs, number of non-detects, relative ranges, and common values. An analytical comparison was not performed, and does not appear warranted from the visual analysis. Because the data sets contain values obtained from samples at various depths, the defined background values are valid for comparison to both surface and deep soil samples from contaminated areas.

Non-detect samples were recorded at half their value. The value of a non-detect is the sample detection limit. The data sets used for the statistical analysis are provided in Appendix C. Non-detects are indicated within each data set along with which report the data came from. The data set for cadmium has a large number of non-detects, with chromium and lead following in percentage of non-detect derived values. When the values in the data set that are derived from non-detects drive the UCL, the validity of the UCL is brought into question. This is not a problem when the detection limits used on a site are the same as that used to define background. When detection limits are more stringent on site work than on background work, the background UCL may be artificially high. The sensitivity of a data set to the values derived from non-detects can be subjectively evaluated by reducing all the non-detect derived values to the least derived value and observing the change in the UCL. The data set for dissolved lead in water matrix was subjected to this type of analysis. The non-detect derived values for this set make up 70% of the data and range from 20% to 83% of the UCL. Reducing all non-detect derived values to less than 0.01% of the UCL only reduced the UCL value by 25%. The cadmium data sets are expected to react similarly. However, all of the other data sets, except for mercury, are stronger in this respect. Background values for mercury are not presented as almost all of the values in the data set are non-detects, and insufficient "hits" exist to evaluate the validity of the value derived from the non-detects. The over estimating of the actual upper mean background values due to elevated non-detect derived values is not expected to be greater than 10% except for the

cadmium data sets and the dissolved lead data set. The potential over estimation in these sets (depending upon actual detection limits used on the project) could approach 20%.

Comparisons from studies done on Eielson AFB and from the Geochemical Atlas of Alaska were done. The Eielson AFB groundwater data was obtained from a report done for the United States Air Force by Battelle Laboratories (3). Soil data for Eielson AFB was acquired from a separate report by Battelle Laboratories (4). The Eielson data is considered comparable to the Fort Wainwright data because both are in the Tanana-Chena River valley so some similarities may exist in background values. There is expected to be some variation, however, because the geology of Eielson AFB is slightly different from Fort Wainwright. The Geochemical Atlas of Alaska (5) provides information on the correlation between elements and geology. Correlation with results from the Atlas indicate whether the results obtained in this report are reasonable. The following is a summary of the data provided in the Geochemical Atlas:

Table 1-1
Geochemical Data

Element	Mean Concentration for Alaska (mg/kg)	Minimum Concentration for Alaska (mg/kg)	Maximum Concentration for Alaska (mg/kg)	Area Concentration for Fort Wainwright (mg/kg)
Arsenic	17.30	5.00	1,796.00	No Value
Barium	810.98	3.00	64,350.00	983 - 1,413
Cadmium	Not included in survey			
Chromium	114.85	1.00	14,550.00	63 - 100
Lead	12.41	4.00	9,926.00	14 - 25

GEOLOGICAL EXPLANATION OF SOURCES:

Ft. Wainwright is located in the Fairbanks mining district, a historically rich and active source of placer and lode deposit minerals. Full production-mining started in 1903 with earlier prospects likely to have been fairly common.

A review of available literature shows that there are no obvious sources of cadmium or chromium. Arsenic, barium and lead are fairly common throughout the district, and are found in hydrothermal deposits in the Birch Creek Schist and in younger granitic domes. Gilmore Dome and Tungsten Hill contain several old mines and many prospects and sample joints. Steel, Columbia and Smallwood Creeks and their tributaries drain Gilmore Dome and Tungsten Hill south to the Little Chena and Chena Rivers.

Arsenopyrite (FeAsS) is one of the most common and widespread secondary minerals in the Fairbanks district, although not highly concentrated in any one locality. Arsenopyrite is associated with tungsten ores and gold, both found on Gilmore Dome and Tungsten Hill. This is the prime source of widespread background arsenic.

Jamesonite ($Pb_4FeSb_6S_{14}$) is fairly common and is usually mixed with arsenopyrite, stibnite (SB_2S_3), and with free gold. Galena (PbS), is usually associated with Jamesonite in the district. These are the main sources for background lead.

Barium has been found at two locations on Gilmore Dome. Both sites are near the head of Nugget Creek and are found in porphyritic quartz monzonite, quartz mica schist and biotite-actinolite-quartz schist. Twenty-two samples were analyzed. Barium content ranged from 70 to 1,000 ppm, averaging 491 ppm.

Additional information, provided in Appendix E, regarding several heavy metals was obtained by the Department of Commerce and Economic Development for the purpose of checking background levels. Several samples were taken from a traverse along the base of the quarry on Birch Hill. Values for arsenic, barium, cadmium, chromium and lead were obtained along with other heavy metals. The values are generally higher than those used in this report, especially for barium. This data strongly indicates that arsenic, barium, cadmium, chromium and lead are all naturally occurring in the area where the samples were taken.

DATA QUALITY

Data quality was verified by consulting the Chemical Quality Assurance (CQAR) reports associated with the data. Any problems relating to arsenic, barium, cadmium, chromium, and lead found in the CQAR were considered for their effect on the overall quality of the data. None of the problems found warranted excluding use of the data. All the reports used for obtaining samples for UCL calculations had their samples analyzed by a laboratory certified by the Corps of Engineers. This means that the data deliverables are equivalent to EPA Level 3 or better. The sampling took place between 1990 and 1992, for all the data used for background analysis . The laboratory method used for the RCRA metals has not changed since 1988, so any samples analyzed prior to 1988 would not be compatible with the data in this report. The laboratory methods used in analyzing the samples used in this report are either Atomic Adsorption (AA) or Inductively Coupled Plasma (ICP). Both of these methods are SW-846 approved and yield compatible results. Well conditions at the time of sampling can be found in the above referenced reports. The CQAR's for all the data in this report along with mention of any problems found follow:

North Pacific Division Materials Laboratory, Corps of Engineers. Chemical Quality Assurance Report, Fort Wainwright Coal Piles. Reference No. 91-M-421. July 1991
Problems: None

North Pacific Division Materials Laboratory, Corps of Engineers. Chemical Quality Assurance Report, Fort Wainwright Landfill. Reference No. 90-HM-172. July 1990
Problems: Arsenic, barium, cadmium, chromium were low in one of two soil MS. These analytes may have been present at higher levels than reported. Lead may have been present at lower levels than reported in two samples. The remaining MS recoveries were within QC limits.

North Pacific Division Materials Laboratory, Corps of Engineers. Quality Assurance Report, Monitoring Wells. Reference No. 89-M-848. November 1989
Problems: Poor matrix spike recovery and reproducibility.

North Pacific Division Materials Laboratory, Corps of Engineers. Quality Assurance Report, Fort Wainwright Basewide Groundwater Monitoring. Reference No. 90-HM-157a. April 1990
Problems: Cadmium and chromium reported close to the project laboratory's detection limits. Blind duplicates disagree with the QA data. Field or laboratory contamination could be the cause. "The QA laboratory had MS recoveries of 124%, at upper end of the QC limits, which may account for the lead discrepancy."

North Pacific Division Materials Laboratory, Corps of Engineers. Quality Assurance Report, Fort Wainwright Basewide Groundwater Monitoring. Reference No. 90-HM-157b. May 1990

Problems: "27 ppm lead found in dissolved but not in the total metals, is probably due either to a sample switch or analytical variations." "The project laboratory's blind duplicate data of barium, chromium, lead and mercury did not agree and are questionable." This problem reflects on the QA lab data and only project data was used in the analysis for background in this report.

North Pacific Division Materials Laboratory, Corps of Engineers. Chemical Quality Assurance Report, Fort Wainwright Basewide Groundwater Monitoring. Reference No. 90-HM-157c. July 1990

Problems: Blind duplicates disagree with QA data. "Project laboratory's high values could be due to some sort of contamination encountered either in the field or laboratory." Project and QA data disagree for lead. "The QA laboratory had MS recoveries of 124%, at the upper end of the QC limits, which may account for the lead discrepancy."

North Pacific Division Materials Laboratory, Corps of Engineers. Chemical Quality Assurance Report, Fort Wainwright Groundwater Monitoring. Reference No. 92-HM-110. March 1992

Problems: " The project blind duplicate and QA data agree for all metals except arsenic. The project data is acceptable based on blind duplicate agreement."

North Pacific Division Materials Laboratory, Corps of Engineers. Chemical Quality Assurance Report, Fort Wainwright Fire Training Pits. Reference No. 90-HM-242. August 1991

Problems: None

North Pacific Division Materials Laboratory, Corps of Engineers. Chemical Quality Assurance Report, Fort Wainwright PSE2, Phase 2. Reference No. 92-HM-227. September 1992

Problems: None

North Pacific Division Materials Laboratory, Corps of Engineers. Chemical Quality Assurance Report, Badger Road DRMO. Reference No. 92-HM-264. December 1992

Problems: The relative percent difference on duplicate samples for barium and chromium were above EPA QC limits. This data is recommended to be J flagged.

North Pacific Division Materials Laboratory, Corps of Engineers. Chemical Quality Assurance Report, Birch Hill UST. Reference No. 91-HM-518. September 1992

Problems: None

North Pacific Division Materials Laboratory, Corps of Engineers. Chemical Quality Assurance Report, Fort Wainwright PX Service Station. Reference No. 93-M-443. January 1993
Problems: Total chromium should be considered estimates.

Omaha District Corps of Engineers. Data Evaluation, Sampling and Analytical Final Report, Fort Wainwright, Alaska. January 1994
Problems: "The batch blanks for the metals analysis contained several metals. The data should be flagged undetected; blank contamination. However, the unflagged data correlate well with the QA data." Data was used because the unflagged data correlates well with the QA data.

RESULTS

The following section summarizes the findings of the statistical analysis and explains why certain data points were deleted from the data set. The values obtained for Eielson AFB are also summarized for both groundwater and soil. Graphs are provided to show the distribution of data and to aid in the determination of whether the distribution is lognormal or normal. The sample detection limits for each data set are given . It should be noted that those samples below detection limits were recorded at half their value. Categories were used to get a better idea of what areas had higher concentrations than others. The major categories are groundwater and soil. Soil is divided into values from North and South of the Chena River . Groundwater is divided into total and dissolved. Total indicates that the sample includes both the particulate and dissolved phase. Dissolved is just the dissolved phase.

GROUNDWATER

GROUNDWATER - TOTAL

Arsenic

An UCL of 36.24 μg/L was computed for arsenic using 159 sample values with a range of 1 to 230 μg/L. The sample detection limit was 5 μg/L for 36 of the non-detects recorded, and 4.5 μg/L for one non-detect. Figure 1-1 is a graph of the distribution of the data. The background UCL found for Eielson AFB is 15 μg/L.

Barium

Barium was determined to have an UCL of 551.22 μg/L using a data set of 172 samples. The data ranges from 8 to 2,000 μg/L. There were three non-detects at sample detection limits of 20, 50 and 200 μg/L. Distribution of the data can be seen in Figure 1-2. A sample value of 4200 μg/L was deleted because it was taken from a location downstream, according to groundwater flow, of a powerplant and could represent contamination from coal or coal ash. Coal or coal ash has been shown to be a source of barium. A 2700 μg/L value was deleted because it came from a sample that was also high in chromium and lead near Building 2111 and was considered to be contaminated. The contamination could be from rubber tires or road dust originating from coal ash (coal ash has been used to sand the roads during the winter). The calculated UCL for barium is 119 μg/L on Eielson AFB.

Cadmium

The UCL of 5.38 μg/L for cadmium was determined using 151 samples ranging in value from 0.25 to 16 μg/L. There were 131 non-detect samples at values with sample detection limits of 0.5, 3, 5, 20 μg/L. Distribution of the data can be seen in Figure 1-3. The UCL for Eielson AFB is < 10 μg/L.

Chromium

Sample values for chromium ranged from 1 to 390 μg/L with a total of 161 samples used. The calculated UCL is 53.01 μg/L compared with < 20 μg/L for Eielson. Eighty-eight (88) non-detects are included in the data set with sample detection limits of 2, 5, 6, 10, 20 μg/L. Distribution of the data is shown in Figure 1-4. Two sample values of 500 and 620 μg/L were deleted from the data set. Both samples were high in barium and lead also. The 500 μg/L value, which was taken from near the power plant and Building 3595, could have been contaminated from used oil or cleaning solvents. The 620 μg/L sample was from an area across from the runway where paint was a possible contamination source. Chromium is often found in yellow paint.

Lead

Lead was determined to have an UCL of 34.07 μg/L, while the UCL for Eielson AFB is < 5 μg/L. Sample values ranged from 0.50 to 160 μg/L and a total of 159 values were used. There were 82 non-detects included at sample detection limits of 1, 2, 4, and 5 μg/L. A histogram showing distribution of the data is provided in Figure 1-5. Two values of 76,000 and 74,000 μg/L were deleted from the data set because of their proximity to the

North Post Site where POL removal occurred. Samples for dissolved and other total lead at the same monitoring well had significantly lower values, so the sample results were considered to be inaccurate and were not included in the analysis. Other sample data that were deleted include values of 1,800, 370, 290, and 250 μg/L. The 1,800 μg/L value was adjacent to a UST tank that held leaded fuel. The 370 μg/L sample came from a location with high values for chromium, arsenic and barium, so was determined to be potentially contaminated from a lead-arsenic pesticide, used oil, motor vehicle particulate emissions or vehicle maintenance operations. The 290 μg/L value came from a monitoring well with floating petroleum product and the 250 μg/L sample was deleted because of it's proximity to the PX Gas Station where fuel related contamination was found. Three samples of 170, 120 and 123 μg/L were deleted from the data set because they were taken from an area close to a landfill, where contamination from leachate may have occurred. A value of 140 μg/L was also deleted because it was in the vicinity of the 801 Drum Site where fuel contamination was present.

Table 1-2

Eielson AFB Background Data for Groundwater TOTAL

RCRA Metal	Upper Confidence Limit (μg/L)	Mean (μg/L)
Arsenic	15	8
Barium	119	106
Cadmium	< 10	< 10
Chromium	< 20	< 20
Lead	< 5	< 5

Table 1-3

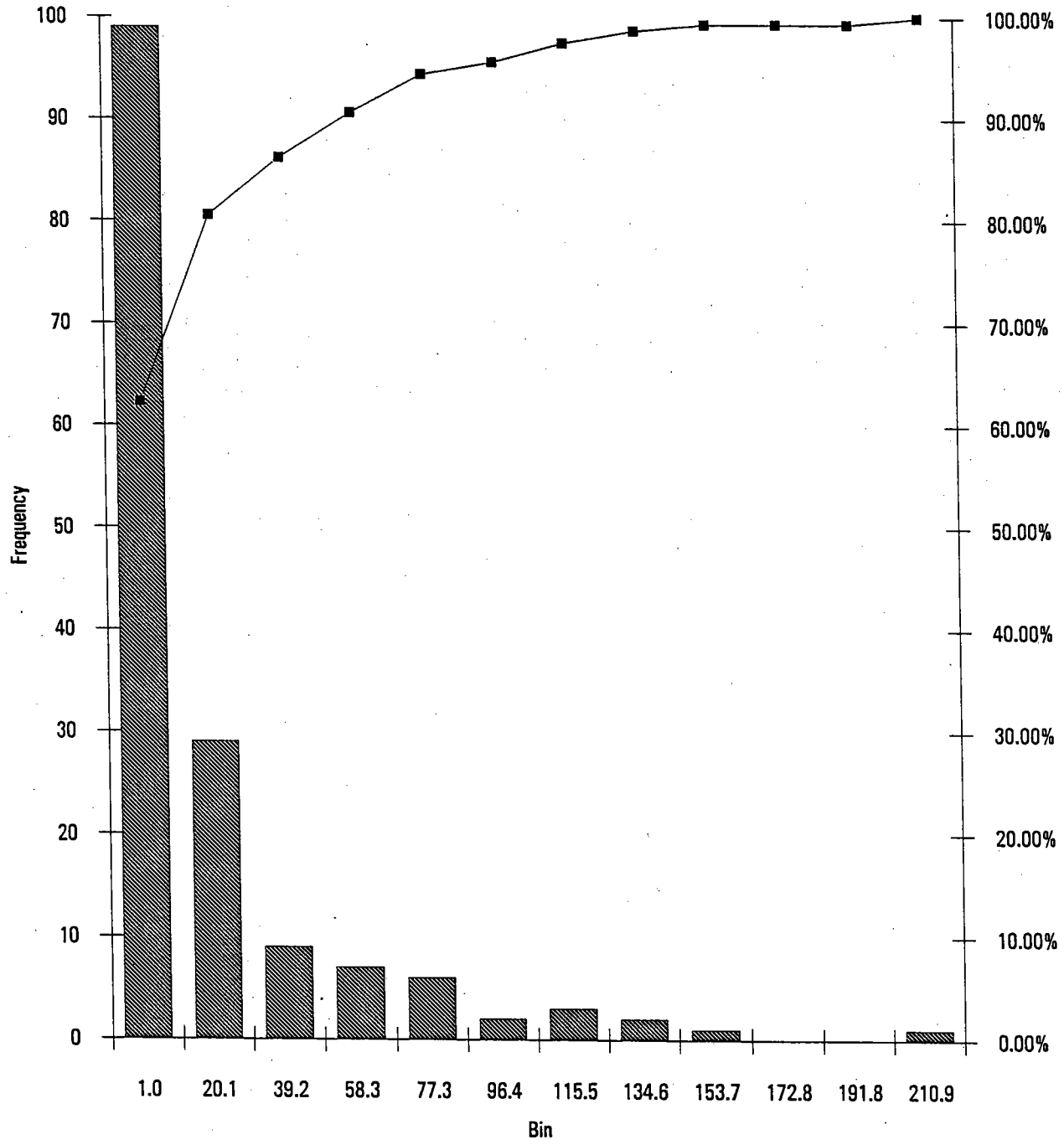
Upper Confidence Limits for RCRA Metals in Groundwater Fort Wainwright TOTAL

RCRA Metal	Lognormal UCL (μg/L)	Normal UCL (μg/L)
Arsenic	*36.24	31.52
Barium	*551.22	481.39
Cadmium	*5.38	4.48
Chromium	*53.01	50.16
Lead	*34.07	24.16

* Indicates the more accurate value as determined by distribution

Figure 1-1

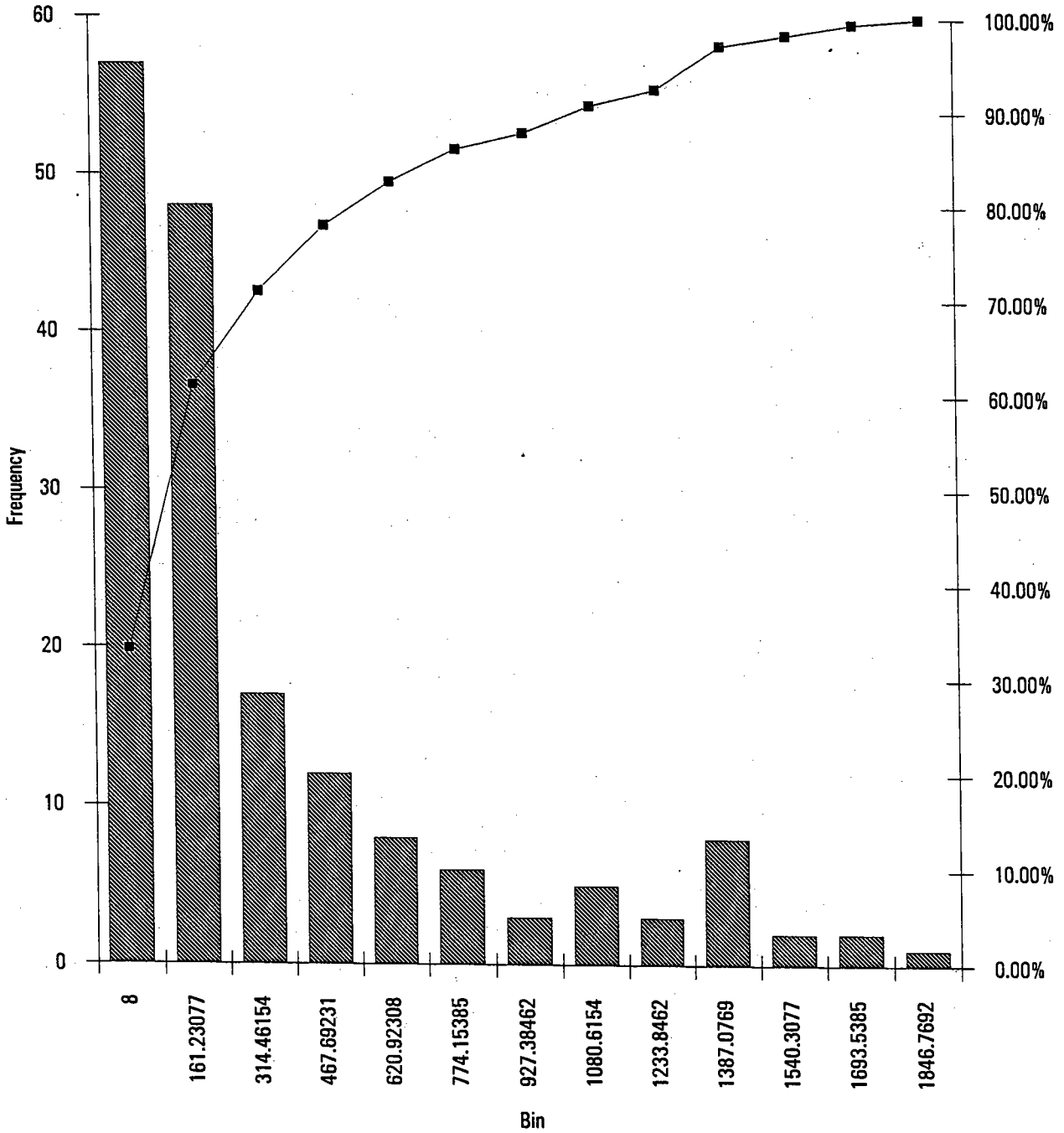
Arsenic
TOTAL
(ug/L)



ARSENTOT.XLC

Figure1-2

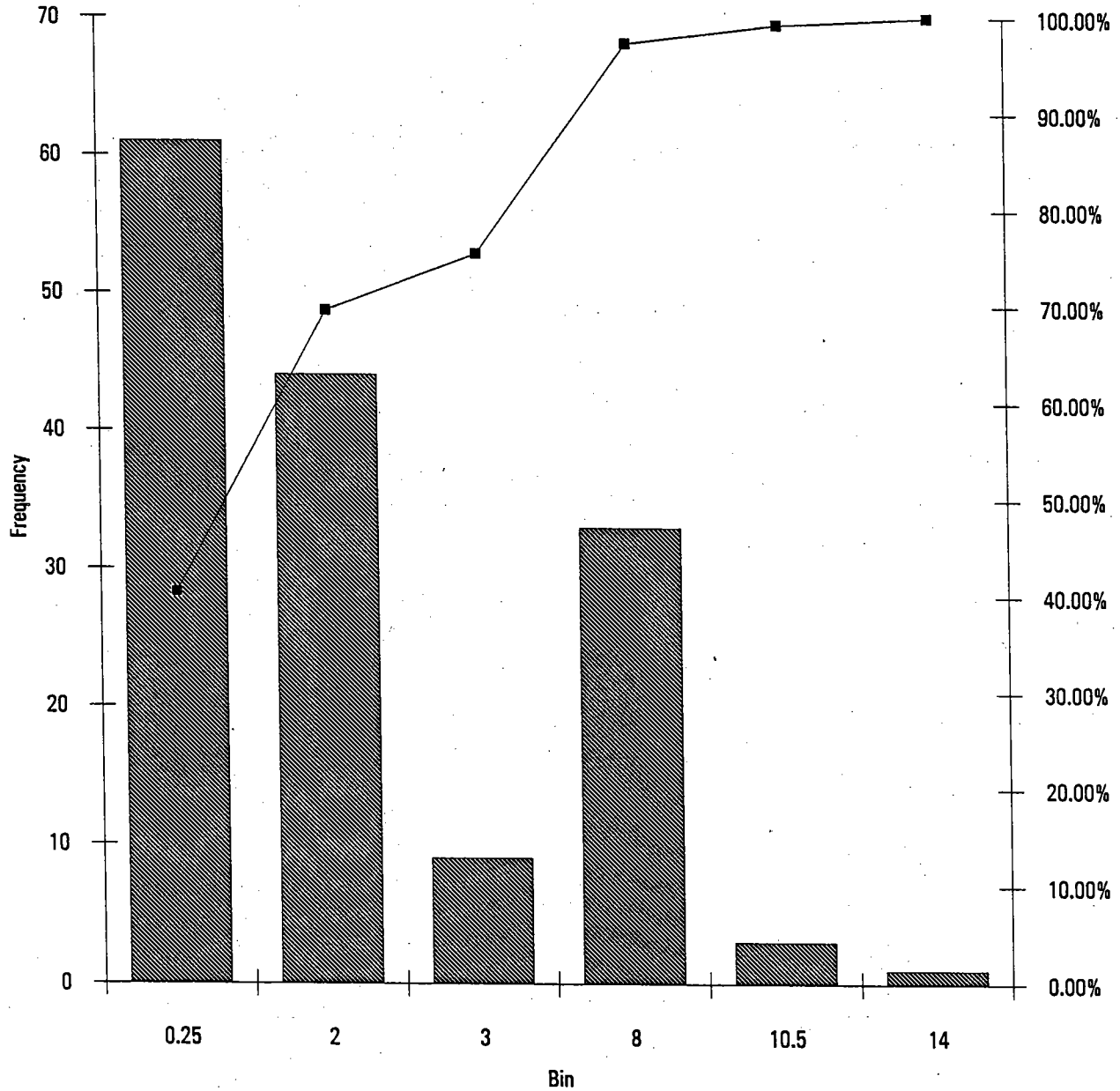
Barium
TOTAL
(ug/L)



BARITOT.XLC

Figure 1-3

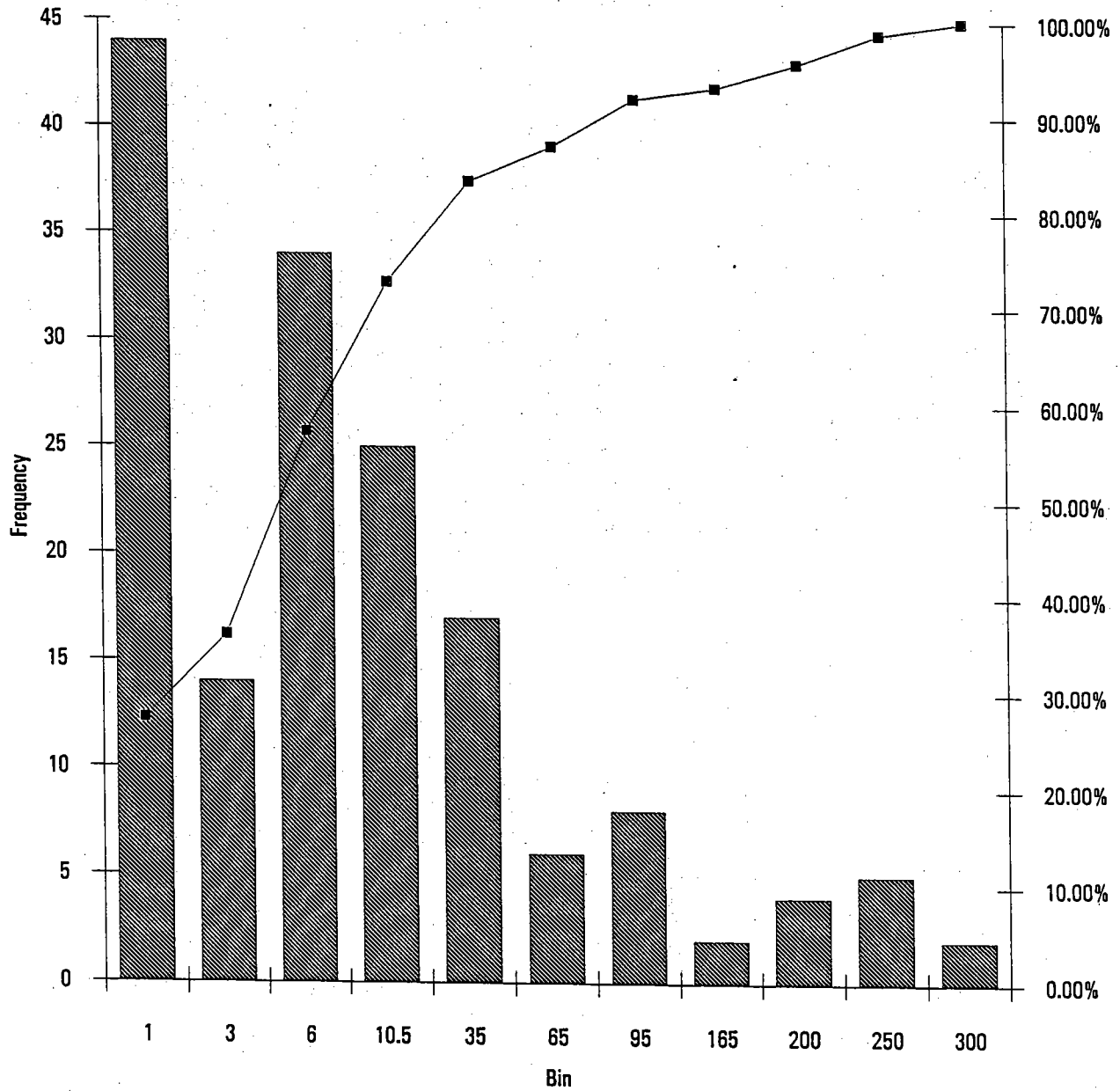
Cadmium
TOTAL
(ug/L)



CADMITOT.XLC

Figure 1-4

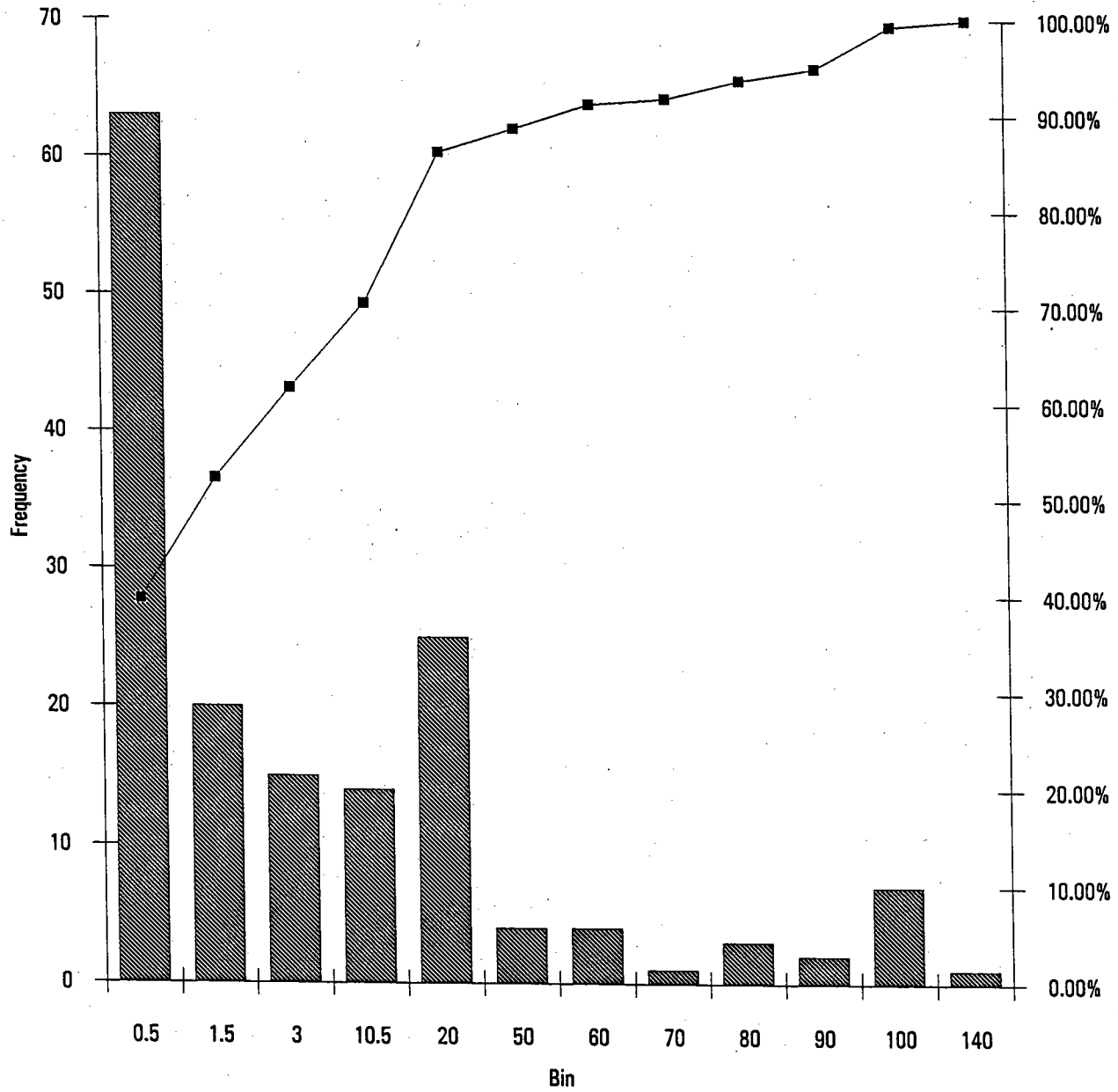
Chromium
TOTAL
(ug/L)



CHROMTOT.XLC

Figure 1-5

Lead
TOTAL
(ug/L)



LEADTOT.XLC

GROUNDWATER - DISSOLVED

Arsenic

An UCL of 8.99 μg/L was calculated for arsenic using fourty (40) sample values. Sample values range from 1 to 56 μg/L . Seventeen (17) non-detects were included with sample detection limits of 2, 2.5, and 5 μg/L. Figure 2-1 shows a graph of the distribution. The reported background UCL for arsenic on Eielson AFB is 15 μg/L.

Barium

Barium has a computed UCL of 231.73 μg/L. Thirty-nine (39) sample values were used in the calculations and the data varied from 25 to 520 μg/L. One non-detect was included with a sample detection limit of 50 μg/L. A graph of the distribution is provided in Figure 2-2. The UCL for barium is 119 μg/L on Eielson AFB.

Cadmium

Forty (40) samples were used to determine an UCL of 3.14 μg/L for cadmium. The samples ranged in value from 0.25 to 10 μg/L. The number of non-detects included is 32 with sample detection limits of 0.5, 2, and 5 μg/L. The detected values were 1, 2.5, 3 and 10 μg/L. Figure 2-3 is a histogram showing the distribution of the data. The UCL for Eielson AFB is < 10 μg/L.

Chromium

An UCL of 4.30 μg/L was calculated for chromium using fourty (40) samples. Thirty-five (35) values included were non-detects at sample detection limits of 2 and 10 μg/L. Detected values ranged from 2.4 to 10 μg/L A histogram of the data is provided in Figure 2-4. The UCL for chromium on Eielson AFB was determined to be <20.

Lead

The UCL computed for lead is 4.51 μg/L. Thirty-nine (39) samples were used with 27 non-detect values with sample detection limits of 4, 2, and 1 μg/L. Detected values ranged from 2 to 27 μg/L. The UCL for lead on Eielson was determined to be < 5 μg/L. Figure 2-5 provides an illustration of the distribution of the data. Two values of 9300 and 6900 μg/L were deleted from the data set due to their proximity to a fuel pipeline break.

Table 1-4

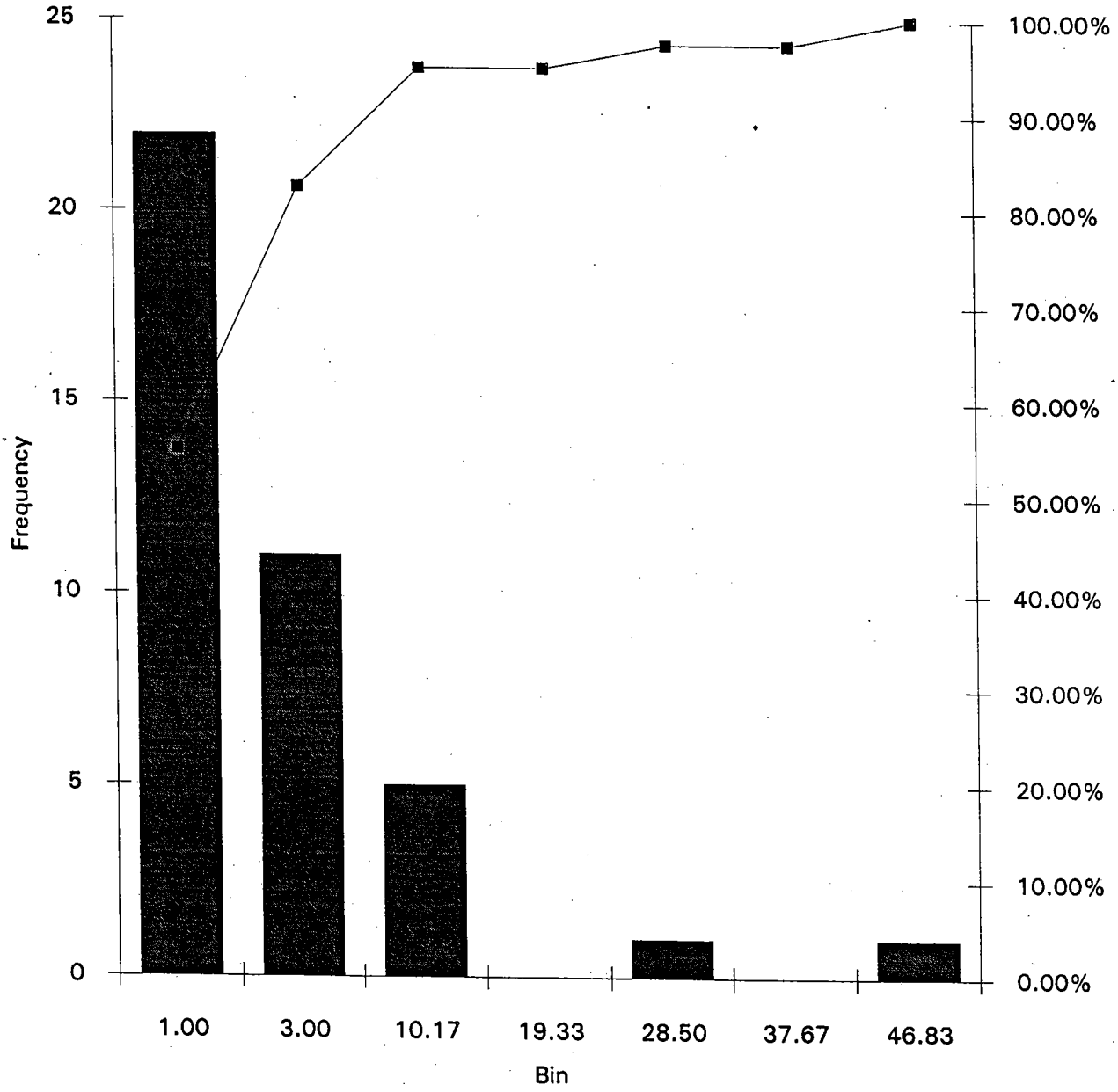
Upper Confidence Limits for Dissolved RCRA Metals in Groundwater Fort Wainwright

RCRA Metal	Lognormal UCL (μg/L)	Normal UCL (μg/L)
Arsenic	*8.99	9.56
Barium	249.61	*231.73
Cadmium	*3.14	2.23
Chromium	*4.30	3.72
Lead	*4.51	4.79

* Indicates the more accurate value as determined by distribution

Figure 2-1

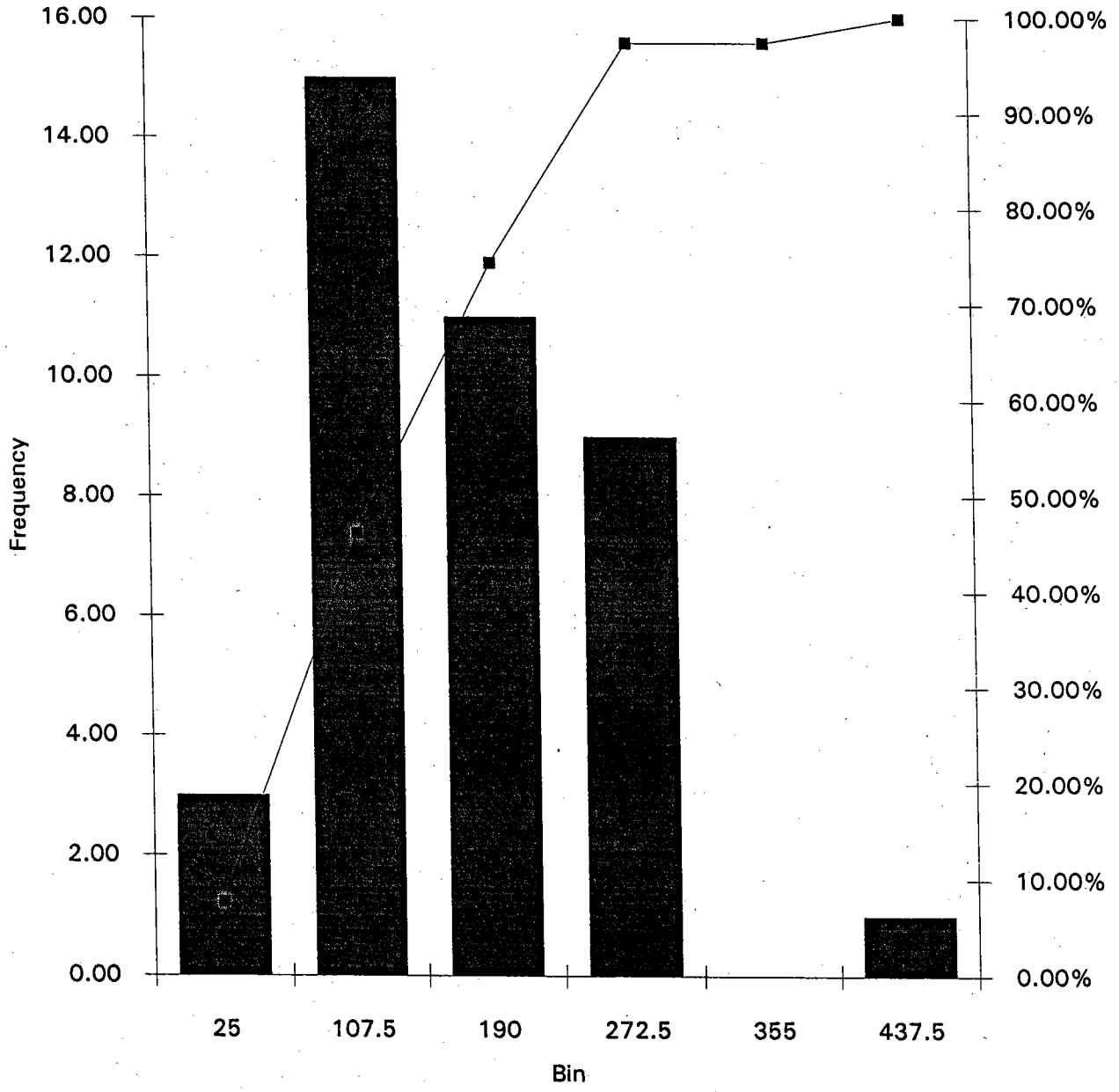
Arsenic
DISSOLVED
(ug/L)



ARAQDSC.XLC

Figure 2-2

Barium
DISSOLVED
(ug/L)



BAAQDSC.XLC

Figure 2-3

Cadmium
DISSOLVED
(ug/L)

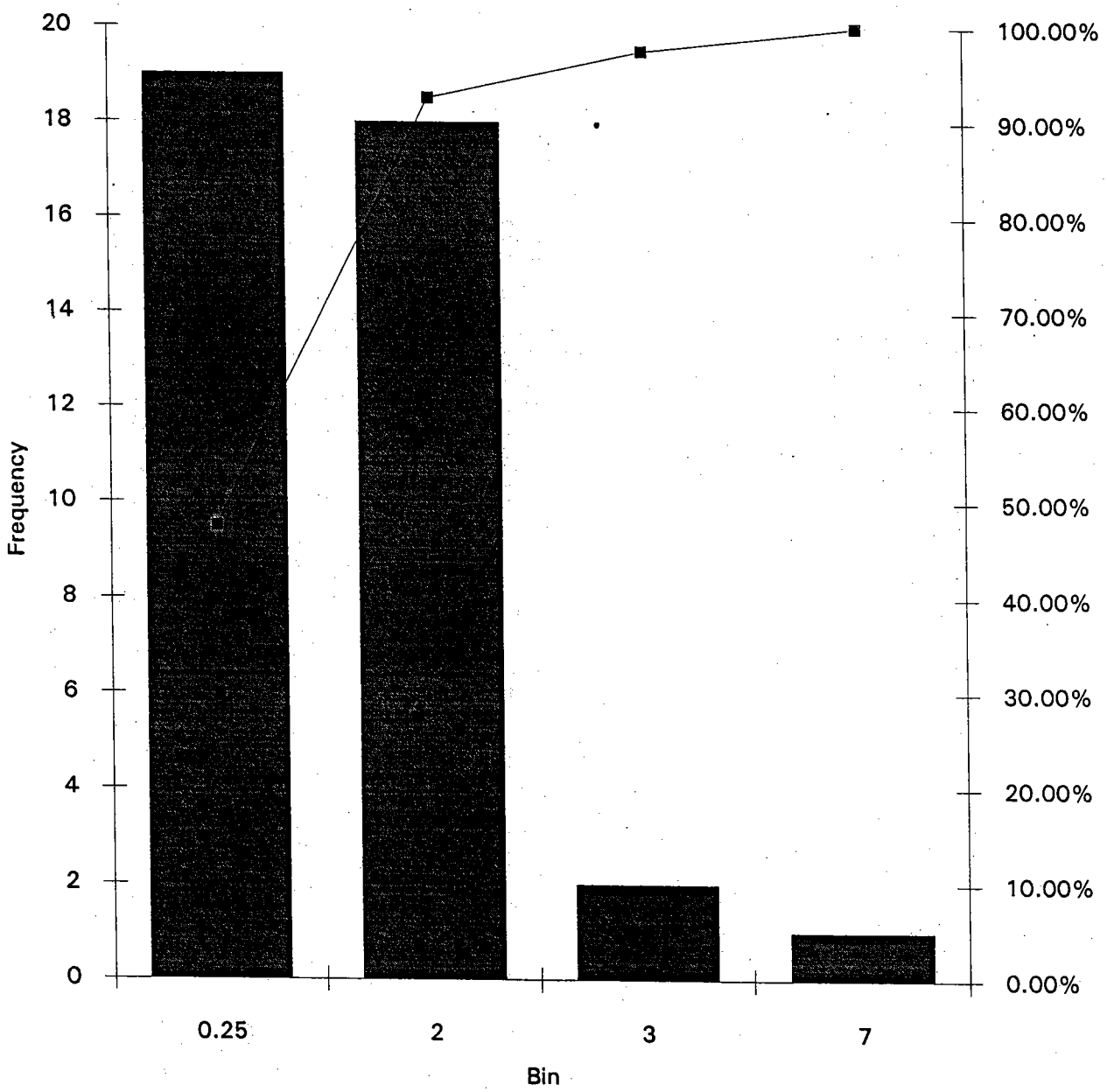
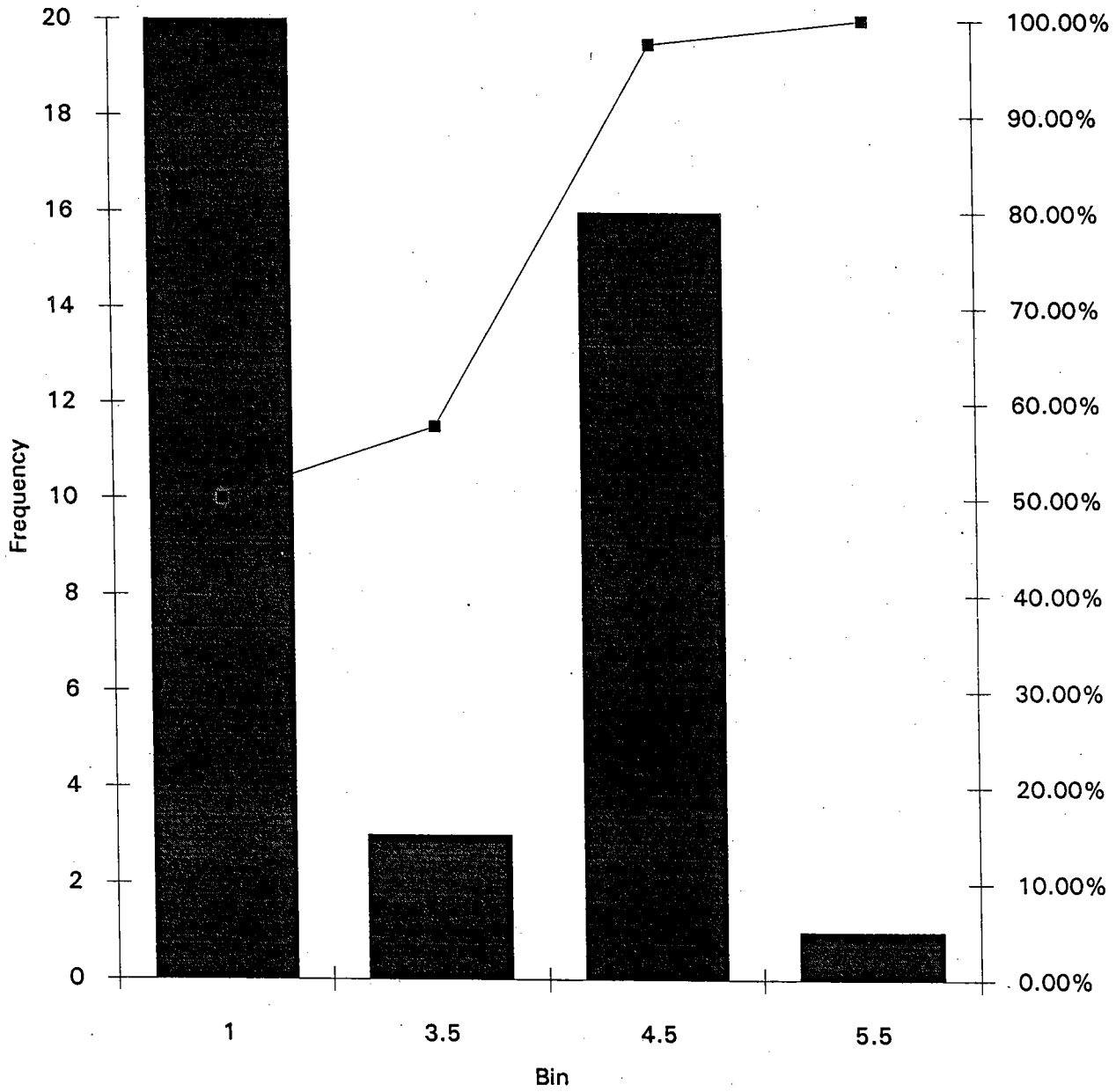


Figure 2-4

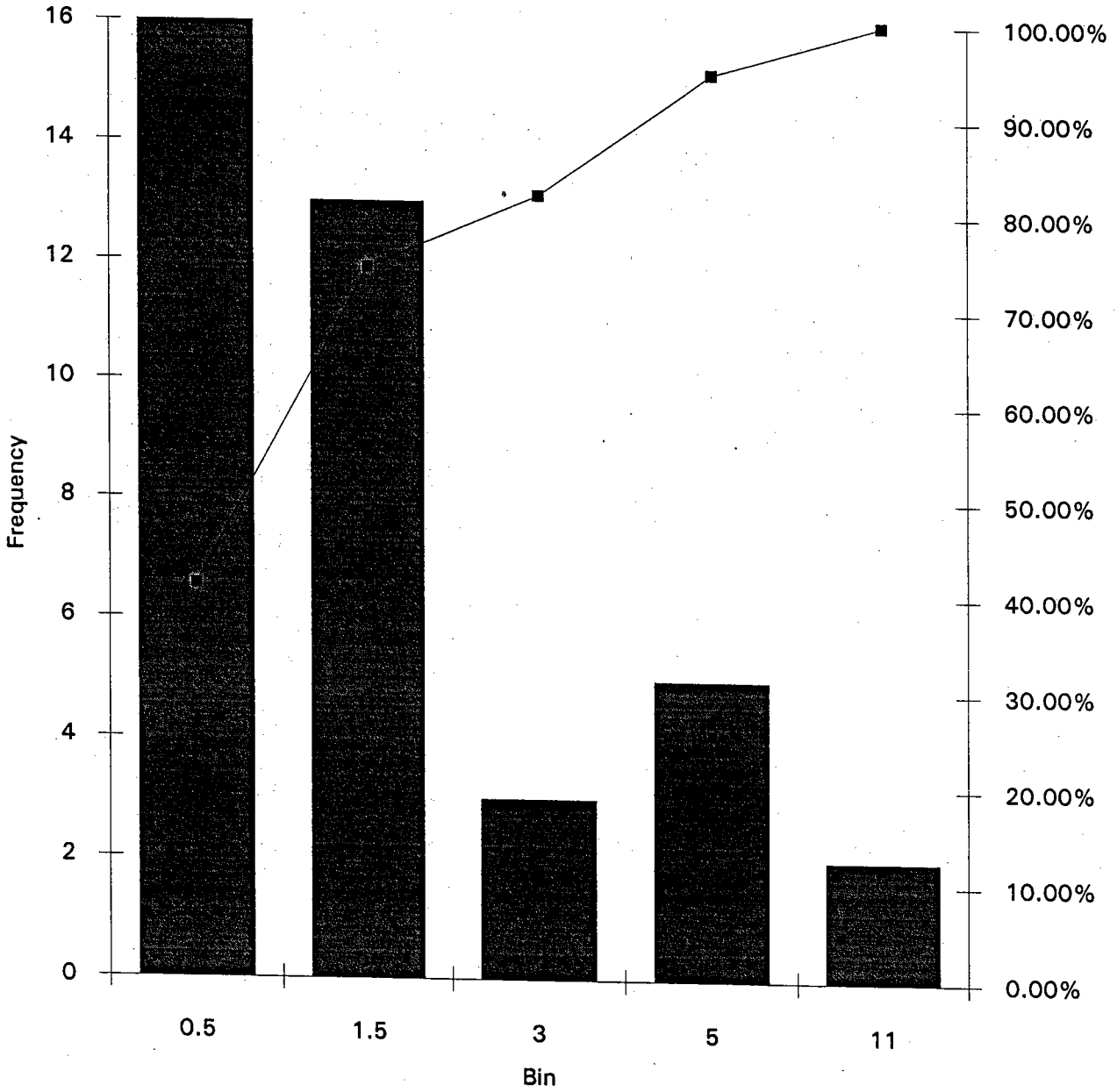
Chromium
DISSOLVED
(ug/L)



CHRAQDSC.XLC

Figure 2-5

Lead
DISSOLVED
(ug/L)



PBAQDSC.XLC

SOIL

SOIL - SOUTH OF CHENA RIVER

Arsenic

A background UCL of 8.46 mg/kg was computed for arsenic using fifty-eight (58) sample values. The data ranges from 0.135 to 29 mg/kg with 5 non-detects at sample detection limits of 0.27, 2, and 10 μg/L. Figure 3-1 shows a graph of the distribution of sample values and Table 1-5 displays the background UCL found for Eielson AFB. The mean concentration for Alaska is 17.30 mg/kg according to the Geochemical Atlas of Alaska. A value of 5.8 mg/kg was deleted because it was taken from sludge at the bottom of a tank excavation.

Barium

Barium has a calculated UCL of 85.20 mg/kg. Fifty-eight (58) samples were used in the analysis and the values range from 35.40 to 234.00 mg/kg. There were no non-detects included in the data set. Figure 3-2 shows the distribution of the data and Table 1-5 gives the UCL found for Eielson AFB. The area concentration for Fort Wainwright from the Geochemical Atlas ranges from 983 to 1, 413 mg/kg with a mean for Alaska of 810 mg/kg. A value of 95 mg/kg was deleted because it was taken from sludge at the bottom of a tank excavation.

Cadmium

Thirty-one (31) samples were used to determine an UCL of 0.58 mg/kg for cadmium. There are 30 non-detects at sample detection limits of 0.47, 0.48, 0.51, 0.52, 0.54, 0.56, 0.57, and 1 mg/kg. The detected value is 5.1 mg/kg. Figure 3-3 provides a histogram of the data. An UCL for cadmium in soil was not determined for Eielson AFB. A value of 2 mg/kg was deleted because it was taken from sludge at the bottom of a tank excavation.

Chromium

An UCL of 14.62 mg/kg was calculated for chromium in soil using fourty-five (45) samples. The data ranged in value from 6 to 46 mg/kg. Ninety-seven percent (97%) of the data was less than 36 mg/kg. There were no non-detects in the data set. A histogram showing the distribution of the data is provided in Figure 3-4. An UCL of 28.3 mg/kg in fluvial soil and 37.8 mg/kg in loess were calculated for Eielson AFB. The Geochemical Atlas provides a Fort Wainwright area concentration of 63 to 100 mg/kg and a mean concentration for Alaska of 114.85 mg/kg. A value of 21.4 mg/kg was deleted because it was taken from sludge at the bottom of a tank excavation.

Lead

Lead was determined to have an UCL of 11.44 mg/kg using fourty-eight (48) samples. The data ranged in value from 2.3 to 118 mg/kg with 95% of the samples less than 30 mg/kg. There were no non-detects in the data set. Distribution of the data can be seen in the histogram provided in Figure 3-5. At Eielson AFB, the UCL in fluvial soil is 11.6 mg/kg and is 9 mg/kg in loess. The concentration range for Fort Wainwright is 14 to 25 mg/kg with a mean concentration for Alaska of 12.41 mg/kg. A value of 118 mg/kg was deleted because it was taken from sludge at the bottom of a tank excavation.

Table 1-5
Eielson AFB Background Data
for
Soil

RCRA Metal	Fluvial Soil (mg/kg)		Loess (mg/kg)	
	UCL	Mean	UCL	Mean
Arsenic	15.5	13.9	16.7	14.1
Barium	153.2	141.2	195.4	184.4
Cadmium	Not considered in report			
Chromium	28.3	26.0	37.8	35.2
Lead	11.6	10.6	9.0	8.5

Table 1-6

Upper Confidence Limits for RCRA Metals South of the Chena River in SOIL Fort Wainwright

RCRA Metal	Lognormal UCL (mg/kg)	Normal UCL (mg/kg)
Arsenic	*8.46	7.42
Barium	*85.20	85.50
Cadmium	*0.58	0.80
Chromium	*14.62	14.42
Lead	*11.44	13.48

* Indicates the more accurate value as determined by distribution

Figure 3-1

Arsenic
(mg/kg)
South of Chena River

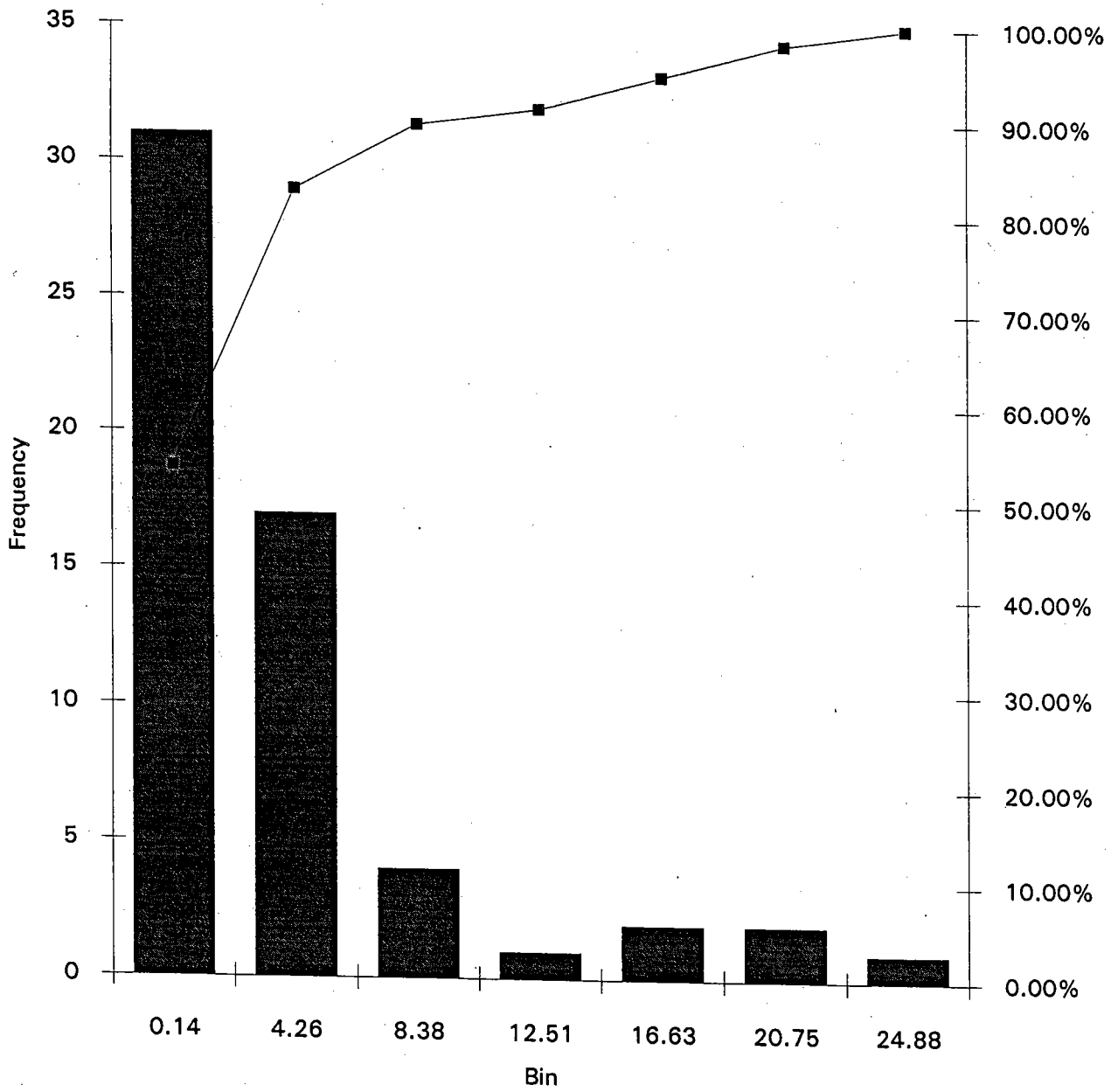


Figure 3-2

Barium
(mg/kg)
South of Chena River

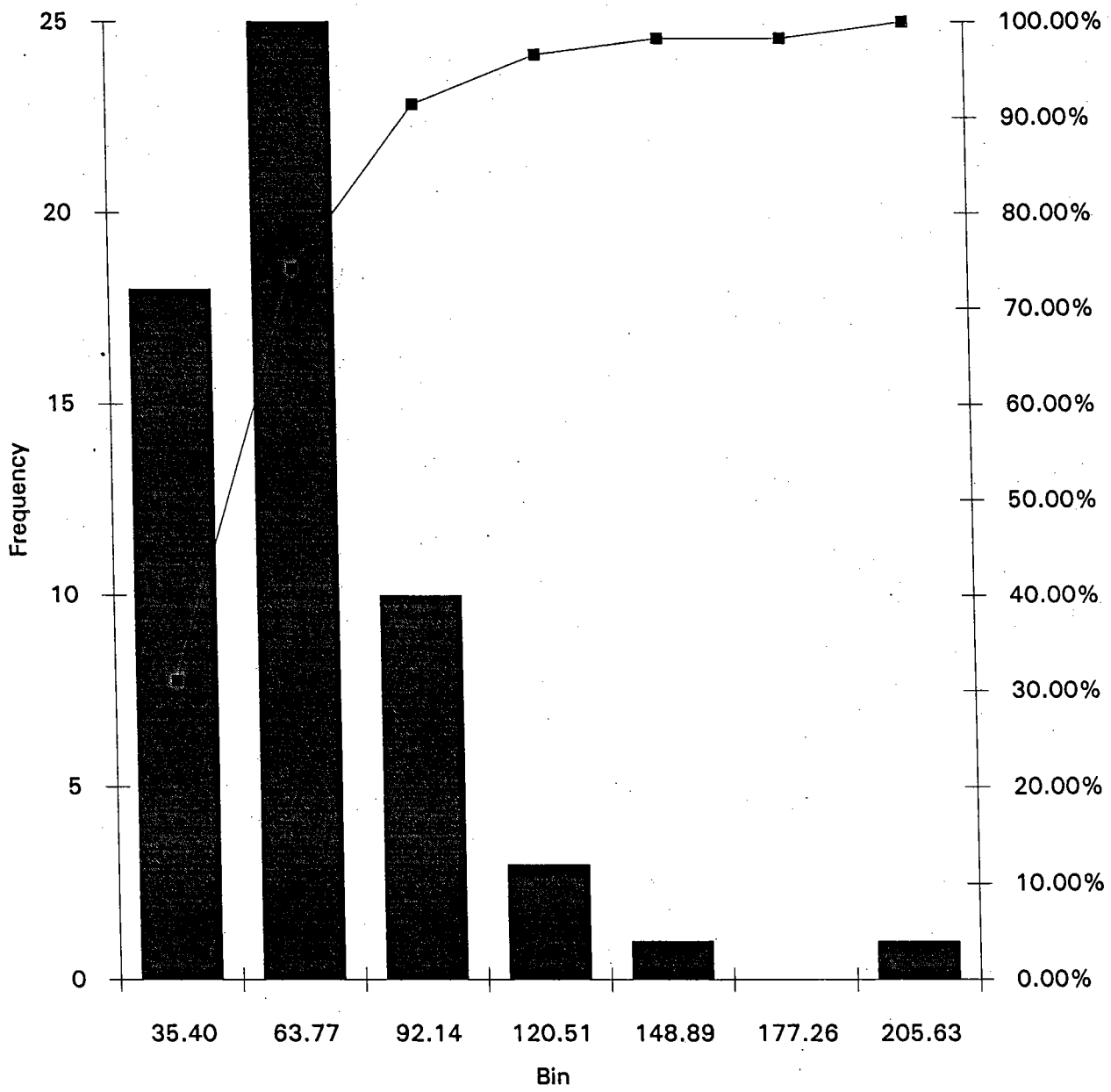
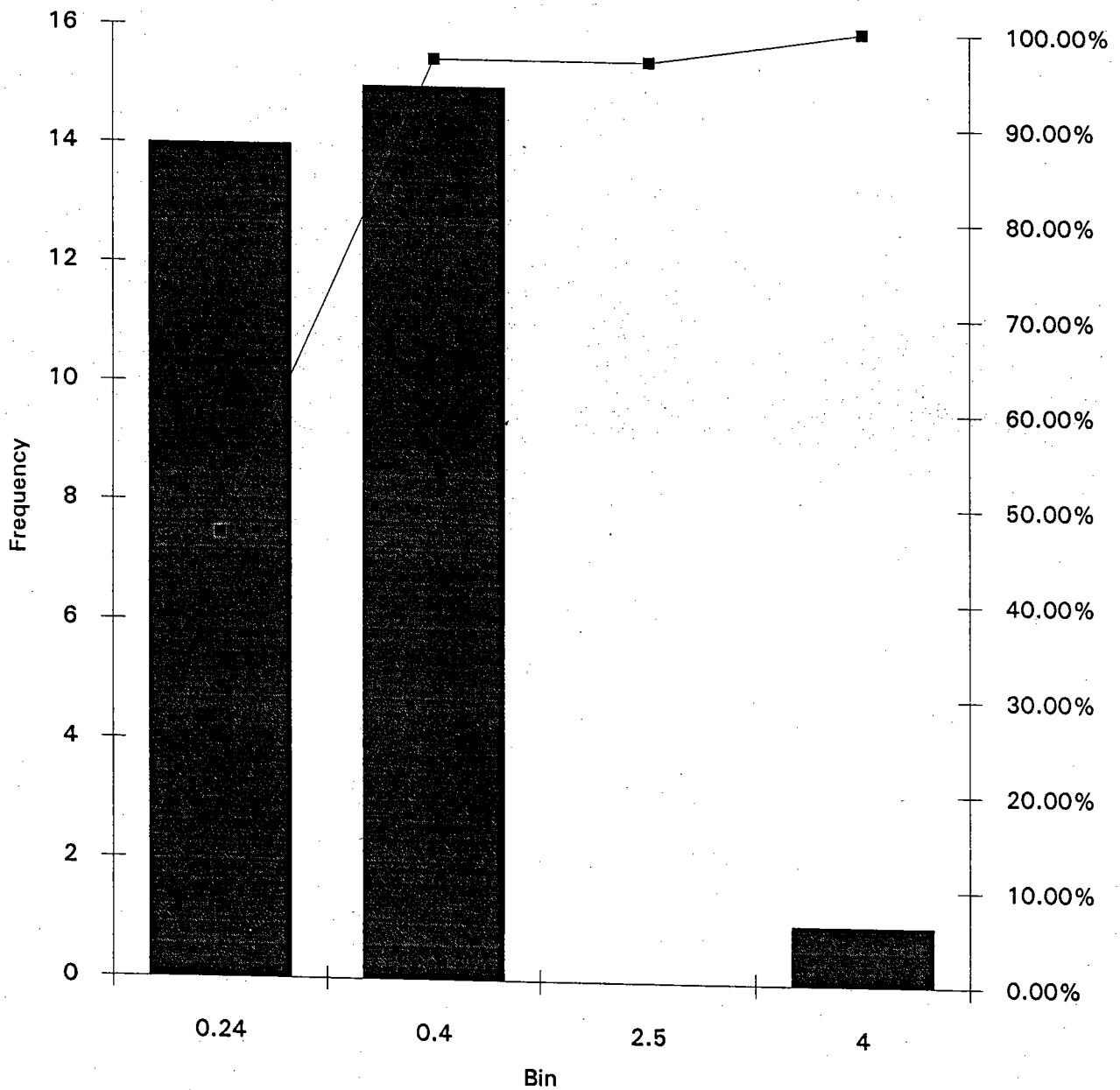


Figure 3-3

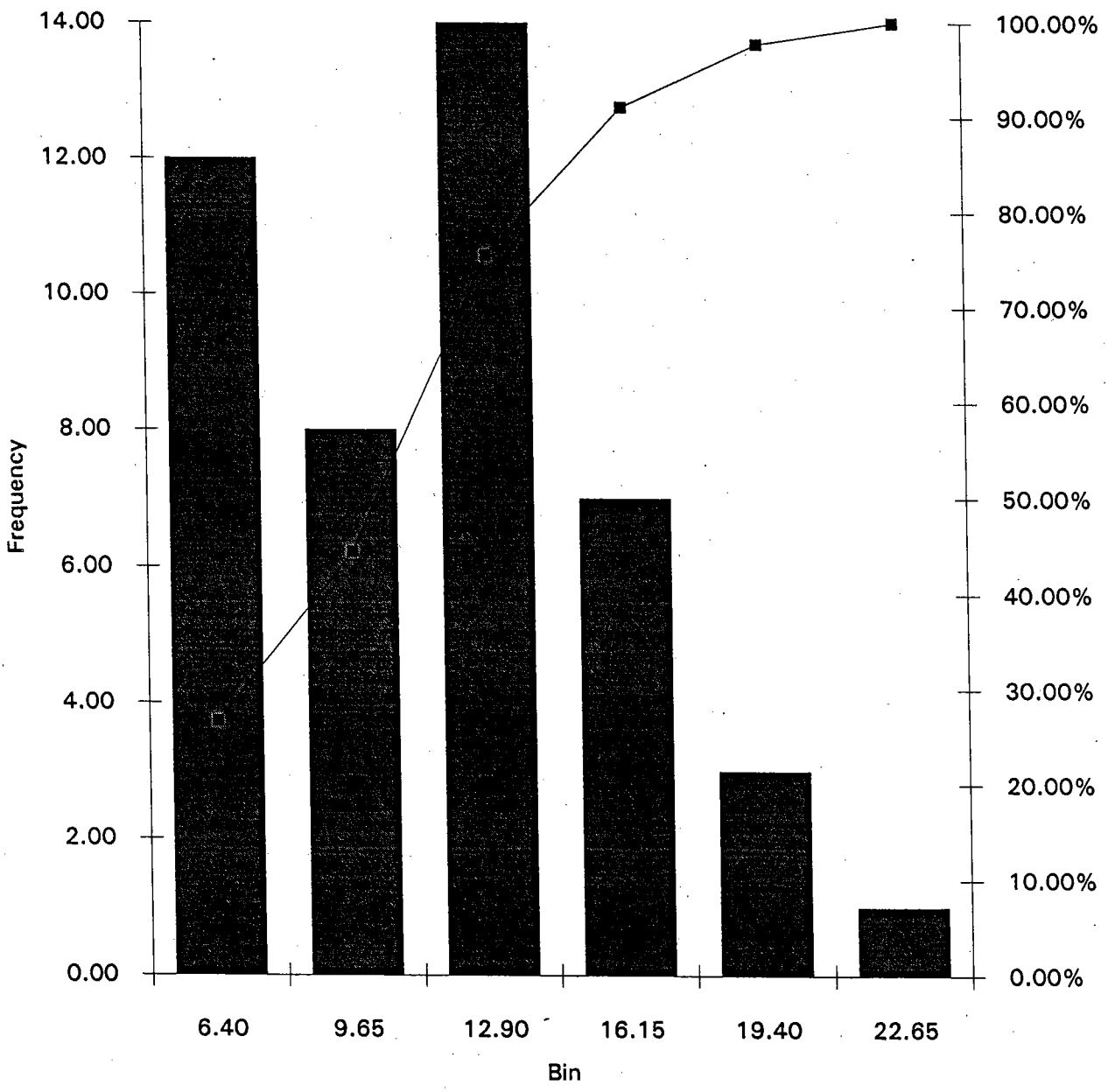
Cadmium
(mg/kg)
South of Chena River



CASOLSC.XLC

Figure 3-4

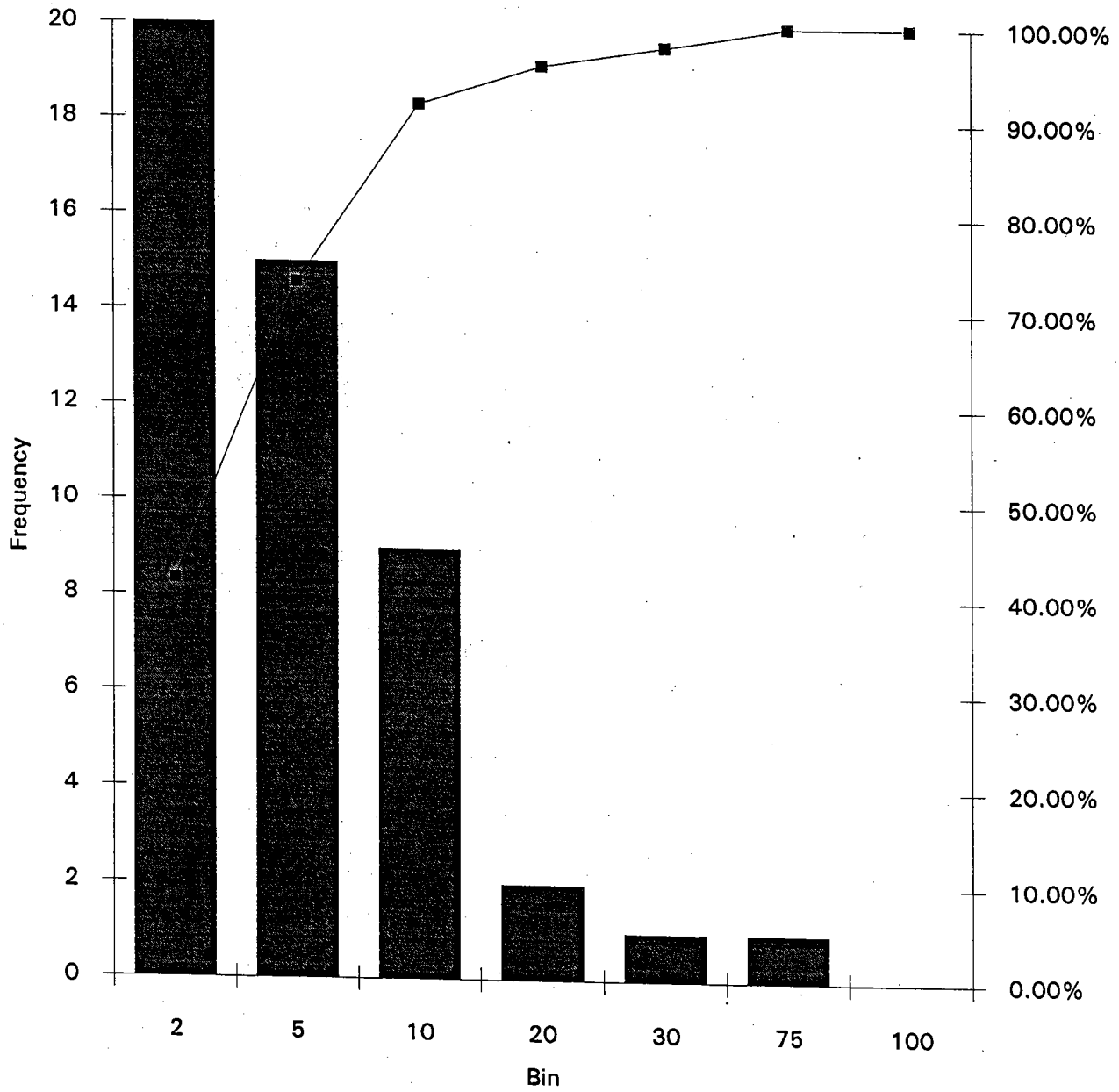
Chromium
(mg/kg)
South of Chena River



CHRSOLSC.XLC

Figure 3-5

Lead
(mg/kg)
South of Chena River



PBSOLSC.XLC

SOIL - NORTH OF CHENA RIVER

Arsenic

A UCL of 11.47 was calculated for arsenic using one hundred and twenty-five (125) sample values. The minimum value is 1.20 mg/kg and the maximum is 38 mg/kg. There were no non-detects in the data set. Figure 4-1 provides a graph of the data distribution and Table 1-6 shows the background UCL and mean values calculated for Eielson AFB. The mean concentration for Alaska found in the Geochemical Atlas is 17.30 mg/kg.

Barium

Barium has a computed background UCL of 154.31 mg/kg. The values vary from 27.50 to 1,350.00 mg/kg and there are a total of one hundered twenty-six (126) sample values. There were no non-detects in the data set. Three surface sample values (4,380, 4,100, 6,418 mg/kg) taken near the landfill were not included in the data set because coal ash is used to cover the landfill and coal ash is considered a source of barium. Table 1-6 displays the background UCL levels calculated for Eielson AFB and a distribution of the data is shown in Figure 4-2. The Geochemical Atlas shows an area concentration of 983 to 1,413 mg/kg and a mean for Alaska of 810.98 mg/kg.

Cadmium

Eighty-eight (88) samples were used to calculate an UCL of 0.83 mg/kg for cadmium. There are 75 non-detects at sample detection values of 1, 2.2, 2.4, 2.5, and 2.9 mg/kg. Detected values ranged from 0.89 to 3.8 mg/kg. An UCL was not determined for cadmium in the study done on Eielson AFB. Figure 4-3 provides a histogram showing the distribution of the data.

Chromium

An UCL of 26.64 mg/kg was calculated for chromium using one hundred and twenty-five (125) samples that were made up of detectable values with no non-detects present. The samples ranged in value from 6 to 46 mg/kg. The UCL's calculated for Eielson AFB are 28.3 mg/kg in fluvial soil and 37.8 mg/kg in loess. Figure 4-4 provides an illustration of the distribution of the data. The area concentration for Fort Wainwright is 63 to 100 mg/kg and the mean concentration for Alaska is 114.85 mg/kg.

Lead

One hundred and twenty-one (121) samples were used to compute an UCL of 13.15 mg/kg for lead on Fort Wainwright, while the UCL for Eielson AFB is 11.6 mg/kg in fluvial soil and 9 mg/kg in loess. There are 59 non-detects with sample detection limits of 5 and 20 mg/kg. Detected values ranged from 2.3 to 97 mg/kg. Figure 4-5 illustrates the distribution of the data. Three values of 170, 140 and 106 mg/kg were deleted from the data set because they were surface samples taken from around a leaded gasoline tank. The mean concentration for Alaska is 12.41 and the area concentration for Fort Wainwright is 14 to 25 mg/kg.

Table 1-7

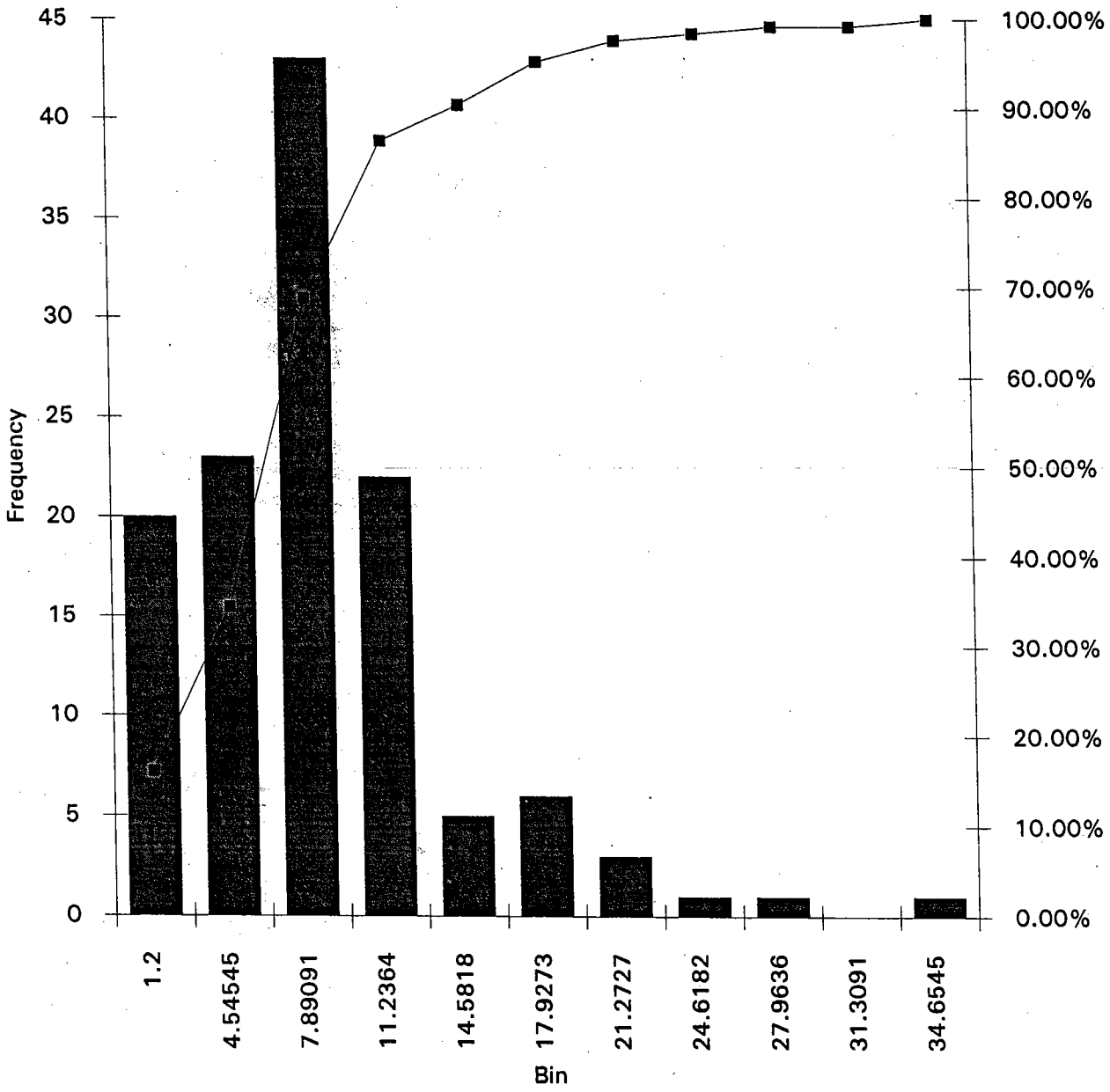
Upper Confidence Limits for RCRA Metals North of the Chena River in Soil Fort Wainwright

RCRA Metal	Lognormal UCL (mg/kg)	Normal UCL (mg/kg)
Arsenic	*11.47	10.91
Barium	*154.31	161.07
Cadmium	*0.83	0.90
Chromium	26.64	*25.72
Lead	*13.15	14.15

* Indicates the more accurate value as determined by distribution

Figure 4-1

Arsenic
(mg/kg)
North of Chena River



ARSOLNC.XLC

Figure 4-2

Barium
(mg/kg)
North of Chena River

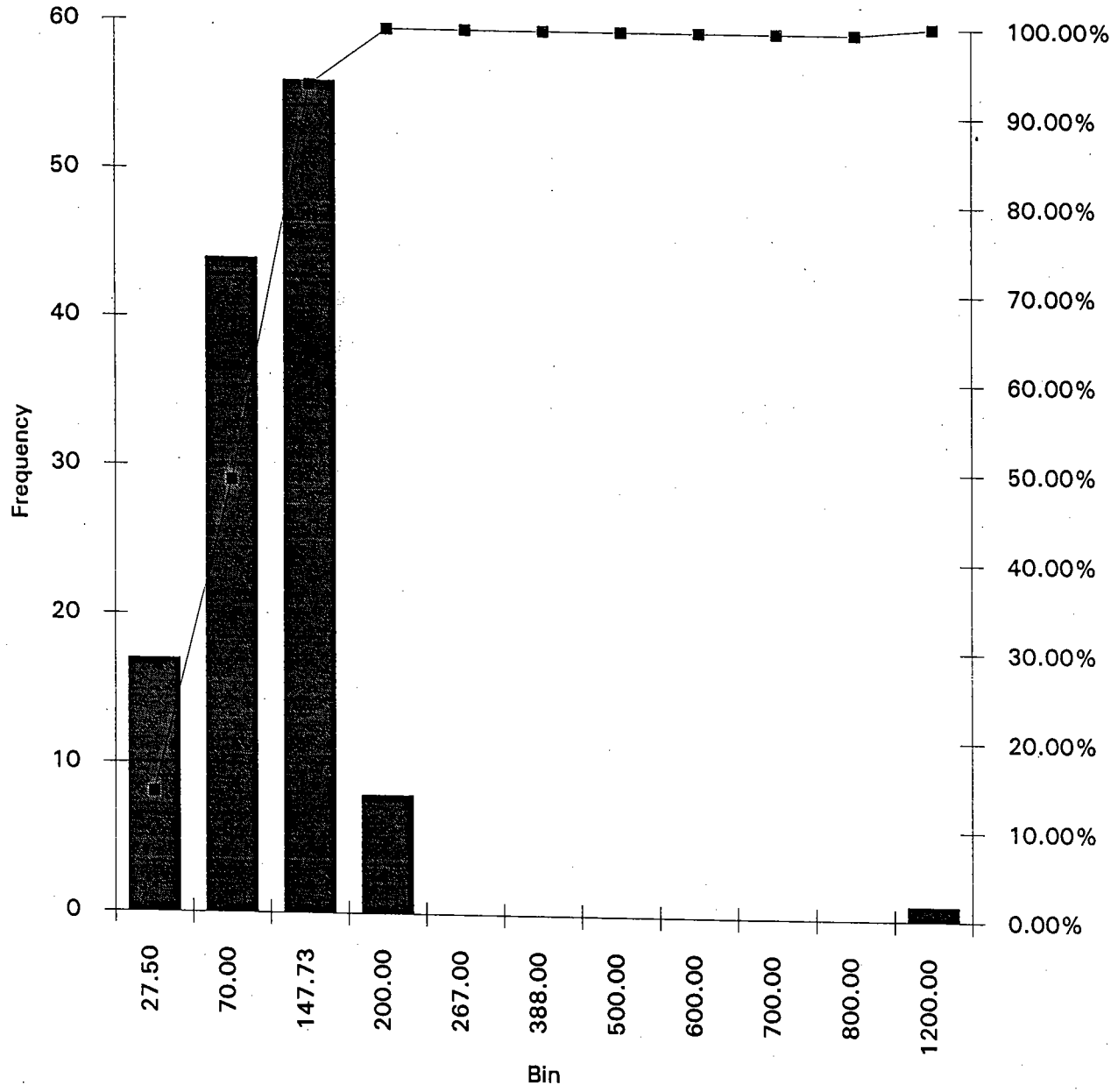
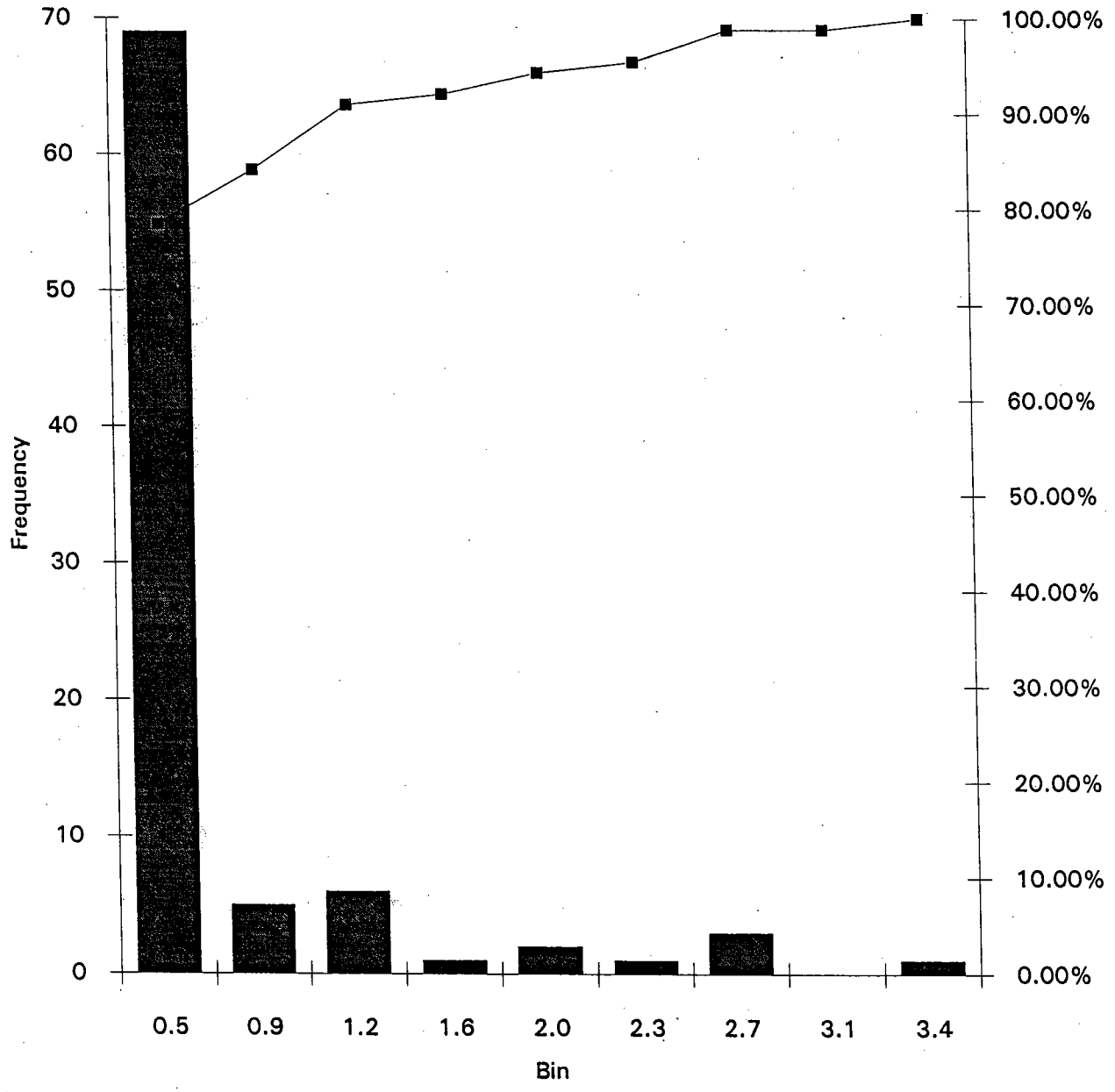


Figure 4-3

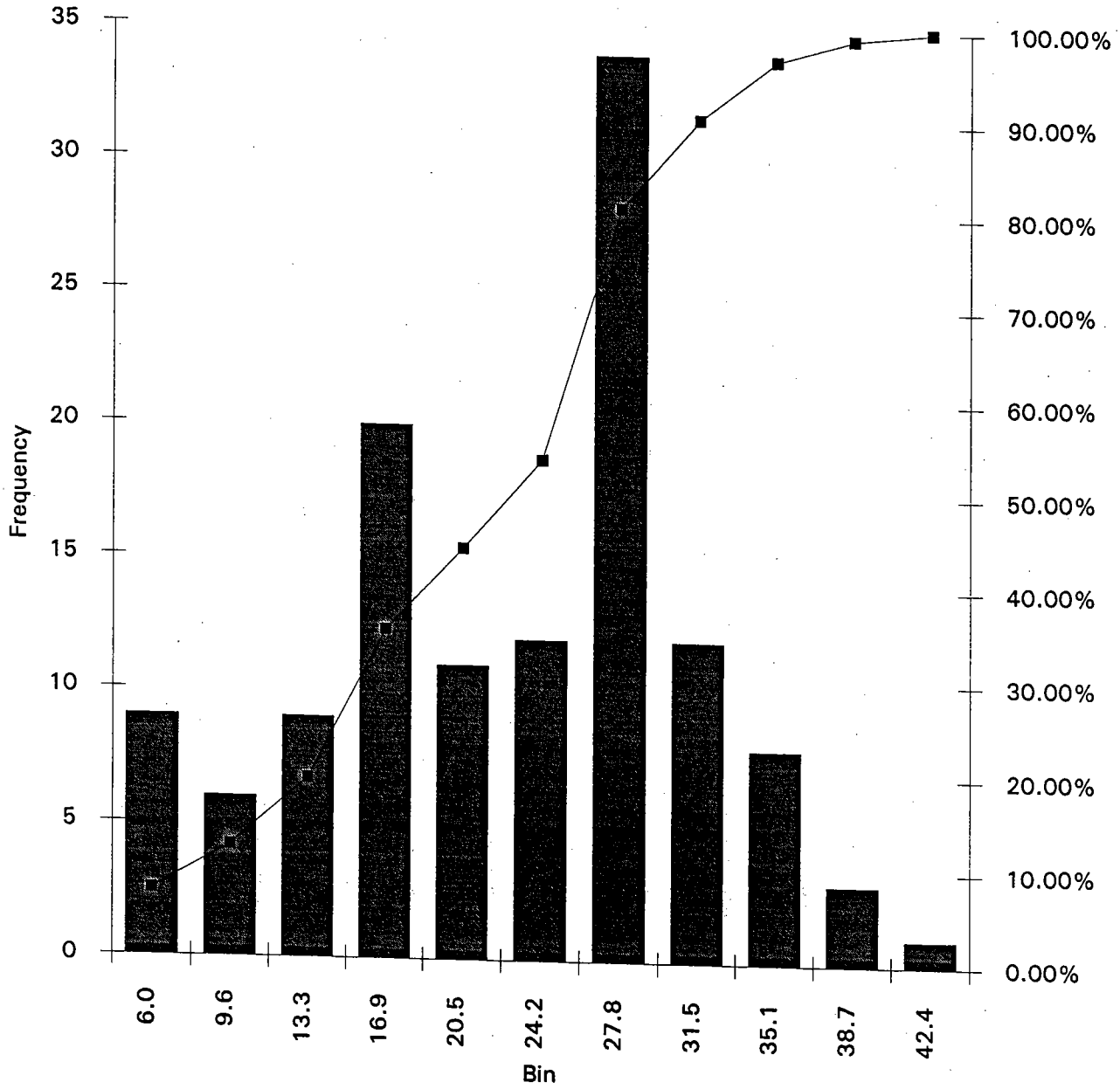
Cadmium
(mg/kg)
North of Chena River



CDSOLNC.XLC

Figure 4-4

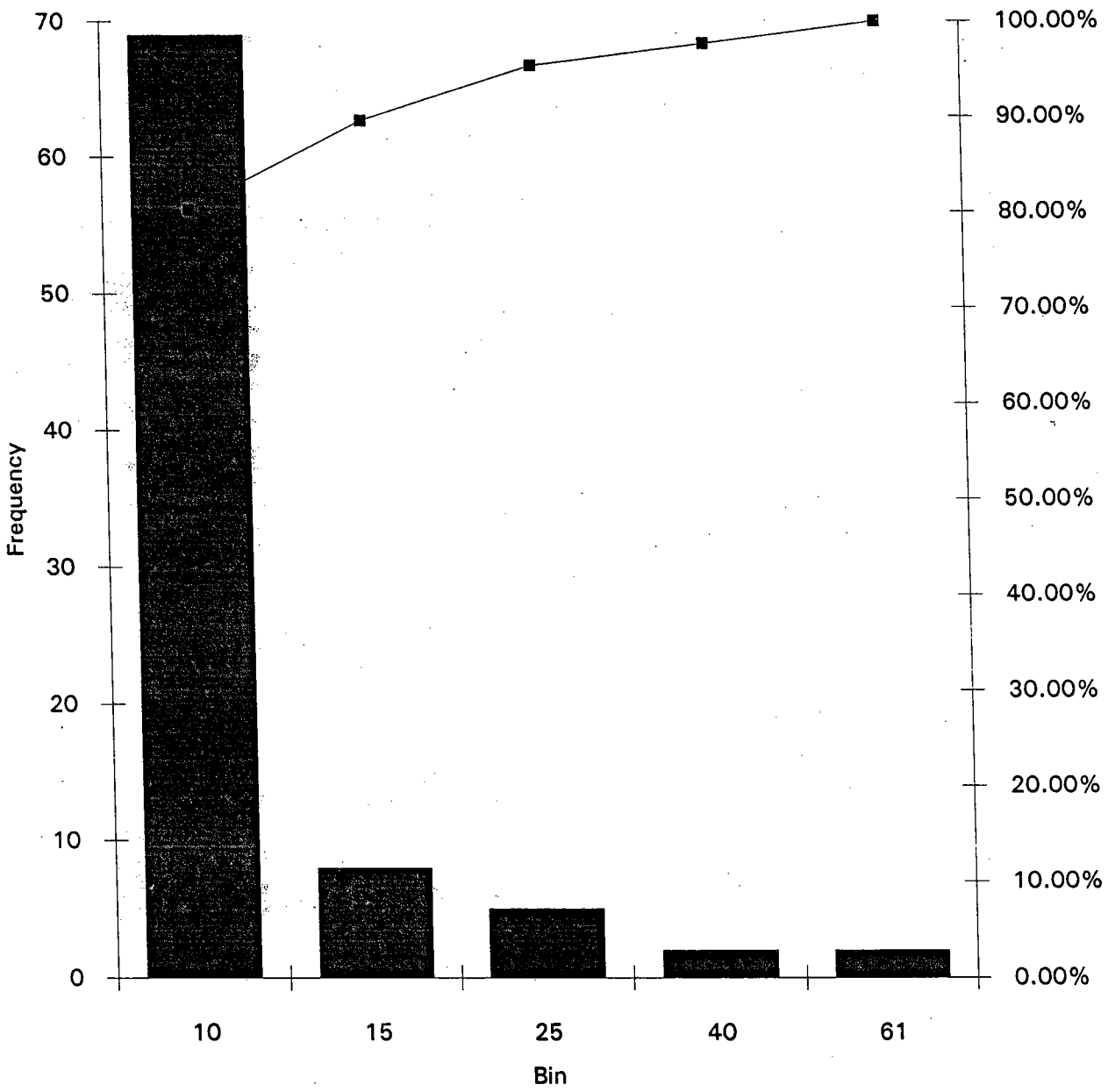
Chromium
(mg/kg)
North of Chena River



CHRSOLNC.XLC

Figure 4-5

Lead
(mg/kg)
North of Chena River



PBSOLNC.XLC

CONCLUSION

Upper Confidence Limits for Fort Wainwright were higher for groundwater and lower for soil than UCL's for Eielson AFB. The UCLs for soil were possibly different because a 90 percent UCL was used for the Eielson AFB data and a 95% UCL was used for Fort Wainwright. A 95 percent UCL would be more conservative in that a 95% UCL allows for 5% error in the estimation and a 90% UCL allows for 10%. Variations in the computed UCLs for groundwater may be due to differences in sample sizes. Data for Eielson was taken from 17 locations compared to 40 locations for Fort Wainwright. Another reason for the difference in value is the Eielson AFB UCL's were calculated using only a *t* statistic for normal distribution. The differences in the geology of Eielson and Fort Wainwright may have also caused the differences in background values. The groundwater samples taken on Fort Wainwright are typically quite turbid. The large difference in background values for total and dissolved metals is evidence that much of the inorganic load is due to particulate in the water. The total inorganic load of arsenic, barium, cadmium and lead in Fort Wainwright groundwater approaches Maximum Contamination Levels (MCLs) and exceeds Risk Based Concentration (RBC) limits for arsenic (see Table 1-8). Chromium exceeds the MCL and approaches the RBC. The dissolved arsenic load also exceeds the RBC carcinogens. The mean concentrations found in this study are most likely due to surface drainage and groundwater flow through the Birch Creek Schist, Gilmore Dome and Tungsten Hill. Mean concentrations approximated in this analysis are below mean concentrations found from the geochemical survey, which indicates the recommended values are reasonable.

Table 1-8
Maximum Contamination Levels and Risk-Based Concentrations for Water

RCRA Metal	MCL[2] (μg/L)	RBC (μg/L)[1]		
		Risk =		
		10^{-6}	10^{-4}	HI=1
Arsenic	50	0.05	5	10
Barium	1,000	N/A	N/A	3000
Cadmium	10	N/A	N/A	20
Chromium (III)	50	N/A	N/A	40,000
Chromium (VI)		N/A	N/A	200
Lead	15[3]	N/A	N/A	N/A

[1] Source: EPA Region 10, Supplemental Risk Assessment Guidance for Superfund, August 1991

[2] Source: State of Alaska Drinking Water Regulation, 18 AAC 80, Department of Environmental Conservation, 1991

[3] Source: U.S. Environmental Protection Agency, Office of Water, Drinking Water Regulations and Health Advisories, April 1992 - Superceeds State MCL

RECOMMENDATIONS

Apparent inorganic contamination of groundwater and soil on Fort Wainwright may be due to natural background levels. Recommended levels for background values of arsenic, barium, cadmium, chromium and lead are given in Table 1-9. The value shown is the UCL plus or minus one standard deviation. This provides the recommended range of values to be considered background concentrations. Action levels should be set close to one standard deviation above the UCL to avoid expending resources to investigate samples within normal laboratory variation of the background value. These values should be used for the purpose of defining added risk.

Table 1-9

Recommended Background Values for Fort Wainwright

RCRA Metal	Matrix	Value ± standard deviation
	South of Chena River	
Arsenic	Soil	8 ± 6 mg/kg
Barium	Soil	85 ± 30 mg/kg
Cadmium	Soil	1 ± 0.8 mg/kg
Chromium	Soil	15 ± 4 mg/kg
Lead	Soil	11 ± 15 mg/kg
	North of the Chena River	
Arsenic	Soil	11 ± 6 mg/kg
Barium	Soil	154 ± 121 mg/kg
Cadmium	Soil	1± 0.7 mg/kg
Chromium	Soil	26 ± 9 mg/kg
Lead	Soil	13 ± 12 mg/kg
	Both North and South of the Chena River	
Arsenic	Water - total	36 ± 36 µg/L
Barium	Water - total	551 ± 437 µg/L
Cadmium	Water - total	5 ± 4 µg/L
Chromium	Water - total	53 ± 72 µg/L
Lead	Water - total	34 ± 32 µg/L
Arsenic	Water - dissolved	9 ± 11 µg/L
Barium	Water - dissolved	250 ± 91 µg/L
Cadmium	Water - dissolved	3 ± 1.8 µg/L
Chromium	Water - dissolved	4 ± 2 µg/L
Lead	Water - dissolved	5 ± 4.9 µg/L

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1. United States Environmental Protection Agency. Supplemental Guidance to RAGS: Calculating the Concentration Term, Publication 9285.7-081, Volume 1, Number 1; May 1992

2. Battelle Pacific Northwest Laboratories, Richard O. Gilbert. Letter Report on Recommended Processes for Implementation by Rocky Flats Plant to Compare Environmental Restoration Site Analytical Results of Samples Environmental Media Obtained in Operable Units to Background Concentrations. July 30, 1993

3. Battelle Pacific Northwest Laboratories. Background Ground-Water Quality, Eielson Air Force Base, Alaska; December 1992

4. Battelle Pacific Northwest Laboratories. Background Soil Concentrations at Eielson Air Force Base; August 1992

5. Geochemistry Group, Earth and Space Sciences Division, Los Alamos National Laboratory. The Geochemical Atlas of Alaska; October 1983

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Cobb, E.H. Summary of References to Mineral Occurrences (Other Than Mineral Fuels and Construction Materials) in the Fairbanks Quadrangle, Alaska. U.S.G.S. OF 76-662; 1976.